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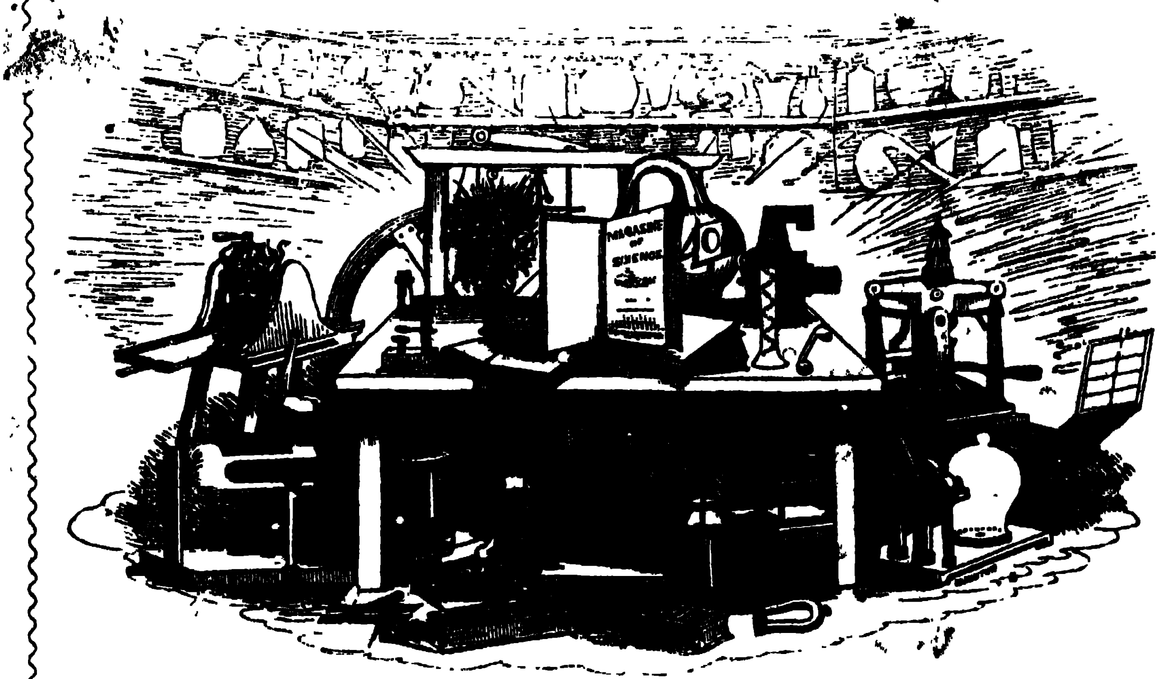
MAGAZINE OF SCIENCE,

AND

SCHOOL OF ARTS:

INTENDED TO ILLUSTRATE THE MOST USEFUL, NOVEL, AND INTERESTING PARTS
OF
NATURAL HISTORY AND EXPERIMENTAL PHILOSOPHY,
ARTISTICAL PROCESSES,
ORNAMENTAL MANUFACTURES, AND THE ARTS OF LIFE.

EDITED BY
G. FRANCIS, F.L.S.
AUTHOR OF THE DICTIONARY OF ARTS AND SCIENCES, CHEMICAL EXPERIMENTS, ELECTRICAL EXPERIMENTS, ETC. ETC.



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PREFACE.

THREE years have now elapsed since this Magazine first made its appearance. It has been conducted throughout with care and energy, and the undiminished, nay increasing demand for it, is the best evidence that our endeavours have met with approbation.

This continued prosperity of our unaspiring little work cannot be attributed to fortuitous circumstances. The year of the publication of our first volume, indeed, was ushered in by great, sudden, and unexpected discoveries in science and art—Photogenic Drawing and the Daguerreotype being among them. The second volume, in like manner, was simultaneous with the Electro-type, Electro-magnetic movements of various kinds, and other equally interesting matters. The last year, on the contrary, has been most barren in discoveries. The meeting of the British Association was admittedly a failure; the Royal Society has produced nothing of interest; the Philosophical Periodicals have been most unfruitful; Mechanical and Manufacturing genius has invented little of public importance; the boasted German and Russian Electro-magnetic Machines are decidedly impracticable; and even the Academie des Sciences at Paris, that is generally so much on the alert in matters of discovery, has been vapid and uninteresting.

With all these discouraging circumstances, attended by a complete stagnation and mistrust in the book trade, still we have steadily pursued our wonted course; and it is no small gratification to reflect upon the steady support we have continually received from the Public. Every thing new and really valuable we have inserted, and every thing of passing public inquiry we have explained. Yet should our Friends have seen articles touching imaginary inventions in the public papers, and wondered why those articles have not appeared with us; we can tell them, that paragraphs in works which are not scientific are not always to be depended upon, thus we should oftentimes quote, and have immediately afterwards to contradict. If such accounts are true in themselves, it [illegible] impossible that we can at all times procure the information requisite to make them valuable; inventors keep their secrets to themselves as much as they can, and do not communicate too freely with

Editors. Again, there are some arts which we can obtain little information in, no satisfactory account being published in our language; for example, Turning, Organ Building, and Acrography.

As far, however, as the above arts are concerned, and some more, of which we have not hitherto treated; we are in well-grounded expectation, very soon, of procuring the desired information upon, as well as of numerous others of more general interest, Dyeing, Bleaching, Thermo-magnetism, &c.; thus we have no hesitation in promising increase of interest to our next volume. One great alteration which we intend to adopt is, in order to include into the body of the text a great part of the answers to Correspondents, putting their inquiries in the shape of queries, and answering them as such, leaving to our other Correspondents to send us other and better answers, if they can, as in the first volume.

The most pleasing duty still remains for us; it is to thank those who have kindly contributed information to our pages. To name particular individuals would be invidious, even could we remember them all; and unjust did we not also express our sense of obligation to our numerous anonymous Friends.

We believe that we have answered all letters received throughout the year, yet these may not have been all which have been sent to us; for while Correspondents send their communications, some to the Publisher, others to the Printer, others even to our former residence, (and which we have now left for many months,) it is possible, particularly in the latter case, that some of them have been delayed or lost.

THE EDITOR.

27, *Cottage Grove, Mile End,*
April 1st, 1842.

The Magazine of Science and School of Arts

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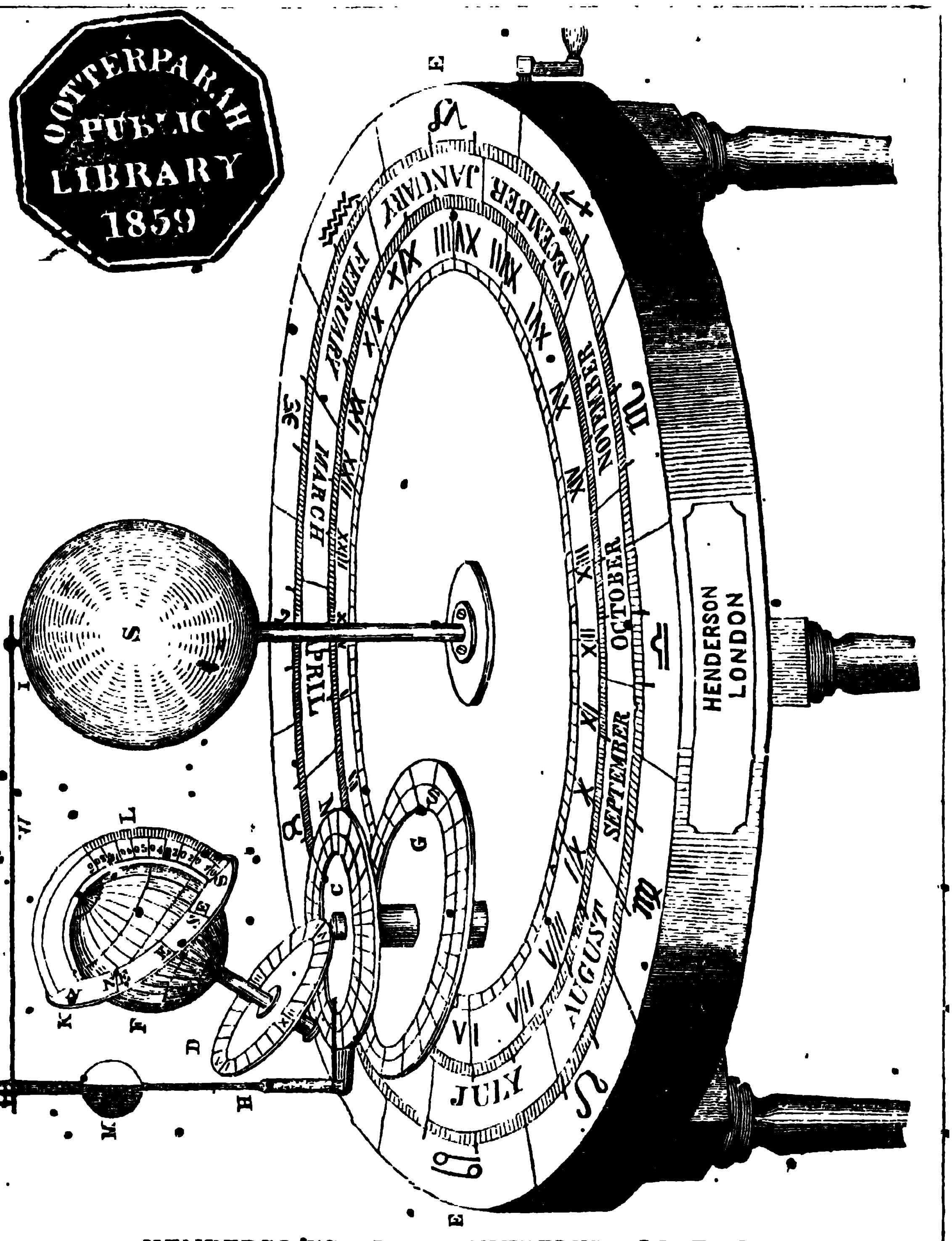

HENDERSON'S THREE-WHEELED ORRERY.

THREE-WHEELED ORRERY.

To the Editor.

SIR.—I inclose for insertion in your Magazine, a perspective view of the external arrangement of a three-wheeled orrery, which I invented during my residence in London, early in the year 1837.

The wheel-work, &c., is inclosed within a large circular frame of mahogany, of about eighteen inches in diameter, E E, on the upper surface of which is carefully laid down the signs of the ecliptic—the days of the month, and hours of the day, as delineated. The sun is represented by a ball, S, in the centre, gilded, and is six inches in diameter, to the right of which is a small terrestial globe, F, three inches in diameter, on which are engraven the several countries of the world, with circles of latitude and longitude, and is surrounded with a small engraven ecliptic circle, K, and circle of altitude, L. The ball, E, representing the earth, is inclined at an angle of about 23½°, and is attached to an axle which ascends from the wheel-work, and by virtue of which connexion it preserves its parallelism in its circular journey round the sun, thereby familiarly exhibiting the cause of the change of the seasons, and different lengths of day and night throughout the year, &c. Immediately under the earth is fixed a small circular dial-plate, on which is engraven the twenty-four hours of day and night, which is very serviceable in attaining the time of terrestial phenomena. Under this dial-plate is another, which is stationary, and on which are engraven the days of the moon's age; and lastly, another circle is attached to the wheel-work, and on which is laid down the degrees, &c. of the nodes of the moon's orbit. This ring or circle is inclined at an angle of about 5¼° to the plane of the frame, E E. This ring has a retrograde motion in the ecliptic in the space of 18 years and 224 days, which is nearly the period of the nodes. Between the circles of the hour, at the foot of the earth's axis, and the circle of the moon's age, a horizontal arm extends from the wheel-work, and carries a perpendicular arm, H, which is partly hollow, for the purpose of affording a vertical motion suitable to the moon's declination, &c. M is a small ball of about three-quarters of an inch in diameter, and is furnished with a black cap, which exactly covers from view one-half of the lunar globe, and to which is attached a kind of forked arm extending upwards, and has a connexion with the sun through the medium of the slight horizontal bar, W, and joined to the sun at I. In short, with this very simple orrery, the following very interesting astronomical phenomena may be distinctly ascertained, and which, so far as I know, is the first time such important results from such simple causes have been effected :—

Phenomena exhibited by the New Orrery.

1.—The unequal lengths of day and night during the year, and hence the cause of the vicissitude of the seasons.
2.—The sun's place in the ecliptic, declination, &c.
3.—The periodic and synodic revolution of the moon.
4.—The moon's diurnal rotation on its axis.
5.—The age and phases of the moon.
6.—The motion of the moon's orbit.
7.—The motion of the apogee of moon's orbit.
8.—The eclipses of the sun, moon, &c.

All the above being effected by a very peculiar arrangement of only three wheels and a pinion. I may add that the moon goes round the earth in the machine in 29 days, 12 hours, 44 minutes, 25½ seconds, and round its own axis in the same time. The earth is moved by hand, is assumed to perform its journey round the sun in 365 days, 5 hours, 48 minutes, and 9 seconds. The moon's orbit makes a retrograde movement through all the signs and degrees of the great ecliptic circle in 6,79[illegible] days, 8 hours, and that of the apogee in 3,23[illegible] days, 18 hours, tropical time.

I generally exhibit this simple orrery in my astronomical lectures, and as it gives general satisfaction, and as a number wish to have copies of its form, I send it to you, in order that they may see it engraved in your widely-circulated Magazine, of which I have been a subscriber since its commencement. I may, at some future period, render you a description of the wheel-work of this instrument, as also of a variety of original and various astronomical machinery, should the present be acceptable to your readers.

E. HENDERSON.

IMPROVEMENT OF THE DAGUERREOTYPE.

THE process of Mr. Wolcroft, an American, patented in England by Mr. Beard, for quickening the action of the Daguerreotype, so as to produce the effect in a few seconds, is now carried into practice at the Polytechnic Institution in taking likenesses. The room fitted up for the purpose is at the top of the building in Cavendish-square. The roof is composed for the most part of large sheets of plate-glass, stained blue to soften the light, and this glass roofing traverses so as to meet the rays of the sun at any part of the day. The sitter is placed on an elevated platform, with a support for the head, and the camera obscura rests on a shelf a few feet distance from him. The construction of the camera itself, as thus applied, constitutes part of Mr. Wolcroft's patent. Instead of using a lens to refract the rays of light to a focus, he employs a reflector, about seven inches diameter. By this means a much greater number of the rays issuing from the object are concentrated within a given space than could be otherwise accomplished, and the image is consequently the brighter. The speculum may also be placed nearer to catch the rays of light than a lens, and this also affords an additional increase of collected rays in the image. The silvered plate, prepared with a coating of the vapors produced by iodine mixed with nitric acid, or with bromine, so as to quicken the action of the light, is put into the focus of the reflecting mirror. The person whose likeness is to be taken keeps his face steady for a few seconds, and the effect on the iodine coating is produced. The plate is then taken away, and excluded carefully from the light until it has been exposed to the vapor of mercury, which attaches to the parts acted on by the light, and the image becomes visible—a perfect fac-simile of nature. Before the plate is exposed to the light, the iodine is washed off, and all further change is thus prevented by exposure. The time occupied by the process varies with the intensity of the light. Some likenesses were taken in five seconds, others occupied twenty, according as the sky was clear or clouded. The difficulty experienced, is to determine the exact time that the plate should remain exposed to the vapor of mercury, the requisite time is at present determined only by trial, and the judgment of the operator. It must therefore require some practiee to produce the best possible effects.

DISTRIBUTION OF ANIMALS.

On a superficial view, vegetables seem more abundant than animals; so contrary, however, is this to fact, that the species of animals, when compared with those of plants, may be considered in the proportion of 10 to 1. Hence it follows that botany when compared with zoology, is a very limited study: plants, when considered in relation to insects alone, bear no proportion in the number of the species. The phanerogamous plants of Britain have been estimated in round numbers at 1500, while the insects that have already been discovered in this country (and probably many hundreds still remain unknown) amount to 10,000, which is more than six insects to one plant. It is therefore obvious that the knowledge acquired of the geographical distribution of animals, in comparison with what is known of plants, is slight and unsatisfactory: it is likewise attended with difficulties inseparable from the nature of beings so numerous and diversified, and which will always render it comparatively imperfect. It rarely happens that a single specimen of a plant is found isolated; the botanist can therefore immediately arrive at certain conclusions: if he is in a mountanious country he is enabled to trace, without much difficulty, the lowest and the highest elevation at which a particular species is found; and the nature of the soil, which may be considered the food of the plant, is at once known. But these advantages do not attend the zoologist: his business is with numerous functions in secret; while of the marine tribes he can never hope to be acquainted with more than a more insignificant portion. The following observations must, therefore, be considered as merely an outline of those general laws which seem to regulate the geography of animals.

The distribution of animals on the face of the globe must be considered under two heads, general and particular. The first relates to families or groups inhabiting particular zones, and to others by which they are represented in another hemisphere. The second refers to the local distribution of the animals of any particular country, or to that of individual species. It is to the general distribution of groups, as a celebrated writer has well observed, that the philosophic zoologist should first direct his attention, rather than to the locality of species. By studying nature in her higher groups, we discover that certain functions are developed under different forms, and we begin to discern something of the great plan of providence in the creation of animals, and arrive at general results, which must be for ever hid from those who limit their views to the habitations of species, or to the local distribution of animals.

Animals, like plants, are generally found to be distributed in zones. Fabricius, in speaking of insects, divides the globe into eight climates, which he denominates the Indian, Egyptian, southern, Mediterranean, northern, oriental, occidental, and Alpine. In the first he includes the tropics; in the second, the northern region immediately adjacent; in the third, the southern; in the fourth, the countries bordering on the Mediterranean Sea, including also Armenia and Media; in the fifth, the northern part of Asia, where the cold in winter is intense; in the seventh, North America, Japan, and China; and in the eighth, all those mountains whose summits are covered with eternal snow. It is, however, easy to perceive, that this, though a very ingenious, is a very artificial theory; the divisions are vague and arbitrary, and we know that animals of one country differ essentially from those of another, although both may enjoy the same degree of temperature. M. Latreille has therefore attempted a more definite theory. His two primary divisions are the arctic and the antarctic climates, according to their situation above or below the equinoctial line; and taking 12° of latitude for each climate, he subdivides the whole into twelve. Beginning at 84° N. L., he has seven arctic climates: viz. the polar, subpolar, superior, intermediate, supratropical, tropical, equatorial: but his antarctic climates, as no land has been discovered below 50° S. L., amount only to five, beginning with the equatorial, and terminating with the superior. He proposes, also, a further division of subclimates, by means of certain meridian lines; separating thus the old world from the new, and subdividing the former into two great portions; an eastern, beginning with India; and a western, with Persia. He proposes, further, that each climate should be considered as having 24° of longitude and 12° of latitude. This system certainly approximates more to what we see in nature than that proposed by Fabricius; yet Mr. Kirby observes with truth, that the division of the globe into climates by equivalent parallels and meridians wears the appearance of an artificial and arbitrary system, rather than of one according to nature.

Mr. Swainson considers that the geographic distribution of animals is intimately connected with the limits of those grand and obvious sections into which the globe is divided; and that in proportion to the geographical proximity of one continent to another, so will be either the proportional identity or the analogy of their respective animals. He considers Europe, Asia, and Africa as agreeing more particularly in possessing certain animals in common, which seem excluded altogether from America and Australia; both of which are not only isolated in situation, but their animals have a difference of form and habit from those of the three continents of the old world. He considers that the animal geography of Asia is connected with that of Australia by the intervention of Borneo, New Guinea, and the neighbouring isles; while that of America unites with Europe towards the polar regions. These five great types or divisions will, of course, present certain affinities or analogies dependent upon other causes, arising from temperature, food, and locality.

Vertebrated animals have a wider range than invertebrated animals, thus resembling man, who is spread over the whole earth: the dog and the crow are found wild in almost every climate; the swallow traverses, in a few days, from the temperate to the torrid zone; and numerous other birds annually perform long migrations. Next to these, insects above all the other Invertebratæ, enjoy the widest range; the house-fly of America and of Europe are precisely the same; and Mr. Swainson has observed in Brazil vast flocks of butterflies, which annually migrate from the interior towards the coast.

Marine animals have, in general, a wider range than those strictly terrestrial. This may probably originate in their being more independent of the effects of temperature. It is remarkable, that, with the exception of the crow and two or three others, the land birds of America differ entirely from those of Europe, yet that nearly all our aquatic species are found both in the new world and in the southern coasts of Africa.

Subordinate to the five geographic groups already noticed, temperature may be considered the principal regulator of the station of animals; it has likewise remarkable influence on their clothing. Many quadrupeds, inhabiting the colder regions, appear in their natural colors during summer, but become white in winter. The same change takes place in the plumage of several land birds; but is not observable in insects, or the other invertebrate groups. Temperature has likewise a great influence on the size and color of animals. The Sphinx convólvuli of Europe is found also in India, but of a much smaller size and more distinctly colored: this is usually the effect of heat upon animals whose chief range is in temperate latitudes. On those which may be considered intertropical, a greater degree of heat not only increases the brilliancy of their colors, but adds to their size. There are many birds and insects common both to Central Brazil and Cayenne; but from the greater heat of the latter country, the specimens are always larger and their plumage more beautiful. Temperature likewise affects the clothing of animals in respect both to quality and quantity. This is more particularly observed in such domesticated animals as have been transplanted from their natural climates. The covering of swine in warm countries consists of bristles of the same form and texture, thinly dispersed; while the same animals in colder climates have an additional coating of fine frizzled wool next the skin, over which the long bristly hairs project. The difference is very remarkable in the swine of northern Europe and those of tropical America, the latter appearing almost naked: it may be observed in a less degree in those of the south of England and the north of Scotland. Similar appearances present themselves among the sheep of warm and cold countries: the fleece of those of England consists entirely of wool, while the sheep of Shetland and Iceland possess a fleece, containing, besides the wool, a number of long hairs, which give it an appearance of being very coarse.

(*To be continued.*

GILDING ON STEEL.

Dissolve any quantity of gold or platina in nitro-muriatic acid (*aqua regia*), until no effervescence is occasioned by the application of heat. Evaporate the solution of gold or platina, thus formed, to dryness, in a gentle heat; (it will then be freed from all excess of acid, which is essential); and redissolve the dry mass in as little water as possible: next take an instrument which is used by chemists for dropping liquids, known by the name of a separating-funnel, having a pear-shaped body, tapering to a fine point, and a neck capable of being stopped with the finger or a cork; which may contain a liquid ounce, or more: fill it with the liquid about one quarter part; and the other three parts, must be filled with the very best sulphuric ether. If this be rightly managed, the two liquids will not mix. Then, place the tube in a horizontal position, and gently turn it round with the finger and thumb. The ether will very soon be impregnated with the platina or gold, which may be known by its change of color. Replace it in a perpendicular position, and let it rest for twenty-four hours; having first stopped the upper orifice with a small cork. The liquid will then be divided into two parts; the darkest colored being underneath. To separate them, take out the cork, and let the dark liquid flow out: when it has disappeared, stop the tube immediately with the cork; and what remains in the tube is fit for use, and may be called the gilding-liquid. Let it be put into a bottle, and tightly corked. When an article is to be gilded, a vessel of glass or unglazed ware must be provided, of just sufficient size to admit the article: it must then be filled with the gilding-liquid, nearly to the top. The steel must be very highly polished, and be entirely free from rust or grease. A basin, full of clean water, must be ready at hand: the article must be immersed into the gilding-liquid, and allowed to remain as short a time as possible; then be taken out, quickly plunged into the water, and well rinsed: it must next be dried with blotting-paper, and be placed in a temperature of 150° Fahr. till it be completely heated throughout; it may then be polished with rouge and a soft leather; or, which is better, be burnished.

It will be as well to observe, perhaps, that the muriate of gold or platina, formed by digesting these metals in nitro-muriatic acid, must be entirely free from all excess of acid; because it will otherwise act too forcibly on the steel, and cause the coating of gold to peel off. Pure gold must be employed. The other must not be shaken with the muriate of gold, as is advised in chemical publications; for it will be sure, then, to contain acid: but, if the two liquids be brought into contact, by the motion described, the affinity existing between ether and gold is so strong, as to overcome the obstacle of gravity, and it will hold the gold in solution.. The ethereal solution may also be concentrated by gentle evaporation. Care must be taken not to wipe the steel until the heat has been applied. This gilding is an effectual protection against rust; and is, at the same time, very ornamental.

OBSERVATIONS ON THE FORMATION OF MISTS IN PARTICULAR SITUATIONS.

BY SIR HUMPHREY DAVY.

All persons who have been accustomed to the observation of nature, must have frequently witnessed the formation of mists over the beds of rivers and lakes in calm and clear weather after sun-set; and whoever has considered these phenomena in relation to the radiation and communication of heat and the nature of vapor, since the publication of MM. Rumford, Leslie, Dalton, and Wells, can hardly have failed to discover the true cause of them. As, however, I am not aware that any work has yet been published in which this cause is fully discussed, and as it involves rather complicated principles, I shall make no apology for offering a few remarks on the subject to the Royal Society.

As soon as the sun has disappeared from any part of the globe, the surface begins to lose heat by radiation, and in greater proportions as the sky is clearer; but the land and water are cooled by this operation in a very different manner: the impression of cooling on the land is limited to the surface, and very slowly transmitted to the interior; whereas in water above 40° Fahrenheit, as soon as the upper stratum is cooled, whether by radiation or evaporation, it sinks in the mass of fluid, and its place is supplied by water from below, and till the temperature of the whole mass is reduced to nearly 40° F., the surface cannot be the coolest part. It follows, therefore, that wherever water exists in considerable mass, and has a temperature nearly equal to that of the land, or only a few degrees below it, and above 40° F. at sun-set, its surface during the night, in calm and clear weather, will be warmer than that of the contiguous land; and the air above the land will necessarily be colder than that above the water; and when they both contain their due proportion of aqueous vapor, and the situation of the ground is such as to permit the cold air from the land to mix with the warmer air above the water, mist or fog will be the result; which will be so much greater in quantity, as the land surrounding or inclosing the water is higher, the water deeper, and the temperature of the water, which will coincide with the quantity or strength of vapor in the air above it, greater.

I shall detail some observations which appear to me to show the correctness of this view. June 9th, 10th, 11th, the temperature of the atmosphere and of the Danube was repeatedly examined during a voyage that I made upon this river from Ratisbone to Vienna, and on each of these days, the sky being perfectly clear, the appearance of mist above the river in the evening uniformly coincided with the diminution of the temperature of the air from three to six degrees *below* that of the river, and the disappearance of fog in the morning with the elevation of the temperature of the air *above* that of the river. From Ratisbone to Passau, the temperature of the Danube was pretty fair throughout the 24 hours, being highest, 62° F. or 62¼° F., between twelve and two o'clock, and about one degree less before sun-rise, the temperature of the air from 61° F. to 73° F. during the day, and from 61° to 51° during the night. Below Passau, the Inn and Ilz flow into the Danube. The Danube was greenish, the Inn had a milky blueness, the Ilz was perfectly pellucid; but from the rapidity with which the Inn descended, its waters at this spot give their tint to the whole surface. On examining the temperature of these rivers at six o'clock, a.m. June 11, that of the Danube was found to be 62° F., that of the Inn 56½° F., and that of the Ilz 56° F.: the temperature of the atmosphere on the banks where their streams mixed, was 54°. The whole surface of the Danube was covered with a thick fog; on the Inn there was a slight mist, and on the Ilz barely a haziness, indicating the deposition of a very small quantity of water. About 100 yards below the place where the three rivers joined, the temperature of the central part of the Danube was 59° F., and here the quantity of mist was less than on the bed of the Danube before the junction; but about half a mile below, the warmer water had again found its place at the surface, and the mist was as copious as before the union of the three rivers. June 12th, the evening was cloudy, and the temperature of the atmosphere remained till after dark higher than that of the river, being, when the last observation was made, 60°F., when there was not the slightest appearance of mist. The sky was clearer before sun-rise on the 13th, and the thermometer immediately after sun-rise, in the air above the river, stood at 55½°F., the temperature of the Danube being 61°F.; a thin mist was seen immediately above the river; but there being no mass of vapor to exclude the sun-beams, it rapidly disappeared; and was not visible a few feet from the surface; and in half an hour the whole atmosphere was perfectly transparent.

In passing along the Rhine from Cologne to Coblentz, May 31st, and June 2nd and 3rd, the nights being very clear, the same phenomenon of the formation of mists was observed, precisely under the same circumstances; but as I could examine the temperature of the air and the river only close to the banks, and in two or three situations, my observations were less precise and less numerous; the mist formed later in the evening, and disappeared sooner in the morning than on the Danube; which was evidently owing to the circumstances of the atmosphere being warmer, and the river colder, the temperature of the one being from 60° F. to 75° F., during the day, and that of the river, where I examined it, from 59° to 60° F.

July 11th, I examined the temperature of the Raab, near Kermond, in Hungary, at seven o'clock p.m., and found it 65° F., that of the atmosphere being 72° F. During the whole evening there were some thin fleecy clouds in the western sky, which being lighted up by the setting sun, greatly interfered with the cooling by radiation from the earth, and at half-past nine, the thermometer, in the atmosphere, was still 69° F., and at half-past ten 67° F., when there was not the slightest appearance of mist. In the morning, before sun-rise, the temperature of the atmosphere on the banks was 61° F., that of the river 64° F., and now the bed of the river was filled with a white thin mist, which entirely disappeared half an hour after sun-rise.

I made similar observations on the Save, in Carniola, in the end of August: on the Izonzo in the Friul, in the middle of September; on the Po near Ferrara, in the end of September; and repeatedly on the Tiber, and on the small lakes in the Campagna of Rome, in the beginning of October; and I have never in any instance observed the formation of mist on a river or lake, when the temperature of the water has been lower than that of the atmosphere, even when the atmosphere was saturated with vapor.

It might, at first view, be supposed, that whether the cooling cause existed in the water or the land, the same consequences ought to result; but the peculiar properties of water, to which I referred in the beginning of the paper, render this impossible. Water in abstracting heat from the atmosphere becomes lighter, and the warmer stratum rests on the surface, and its operation in cooling the atmosphere is extremely slow; besides, the cooled atmospheric stratum remains in contact with it, and water cannot be deposited from vapor, when that vapor is rising into an atmosphere of a higher temperature than its own; and the law holds good however great the difference of temperature. Thus, August 26th, at sun-set, the day after a heavy fall of rain, and when the atmosphere was exceedingly moist, I ascertained the temperature of the Drave, near Spital, in Carinthia, and though it was 14° F. below that of the air, yet the atmosphere above the river was perfectly transparent.

It may be imagined, but without any reference to the cooling agencies of the air from the land, mist may form upon rivers and lakes, merely from the loss of heat by radiation from the air, or the vapor itself immediately above the water; and that the phenomena is merely one of the formation of vapor, the source of heat being in the water, and its deposition, the source of cold, being in the atmosphere; but it is extremely improbable that air or invisible vapor, at common temperatures, can lose any considerable quantity of heat by radiation; and if mist could be formed from such a source, it must always be produced to a great extent upon the ocean in calm weather during the night, particularly under the line and between the tropics, which the journals of voyages sufficiently prove is not the case. I have myself had an opportunity of of making some observations which coincide with this view. During a voyage to and from Pola, I passed the nights of Sept., 3rd, 5th, and 6th, off the coast of Istria; there was very little wind on either of the nights, and from sun-set till nearly midnight it was perfectly calm in all of them. On the 3rd it was cloudy, and the lightning was perceived from a distant thunder-storm, and the vessel was never far from the shore; but on the 5th and 6th the sky was perfectly clear, and the zodiacal light, after sun-set, wonderfully distinct and brilliant, particularly on the 5th, and we passed, by the help of oars, from two to eight miles from the shore. The temperature of the sea at sun-set was 76° F. on the 5th, 77° F. on the 6th, that of the atmosphere immediately above it 78° F. and 79° F. On the 5th at midnight, about five miles from the shore, the temperature of the sea was 74° F., and that of the atmosphere 75° F. There was not the slightest appearance of mist on either of these nights on the open sea, or at any distance from the land; but close under the hills of Istria there was a slight line of haze visible before sun-rise, which was thickest under the highest land; and as we approached, at sun-rise on the 7th, the mountains of the Friul, the tops of those nearest to Trieste were seen rising out of a thick white mist, which had not reached a quarter of a mile from the shore.

After mists have formed above rivers and lakes, their increase seems not only to depend upon the constant operation of the cause which originally produced them, but likewise upon the radiation of heat from the superficial particles of water composing the mist, which produces a descending current of cold air in the very body of the mist, whilst the warm air continually sends up vapors: it is to these circumstances that the phenomena must be ascribed of mists from a river or lake, sometimes arising considerably above the surrounding hills. I have often witnessed this appearance during the month of October, after very still and very clear nights, in the Campagna of Rome above the Tiber, and on Monte Albano over the lakes existing in the ancient craters of this extinguished volcano, and, in one instance, on the 17th of October, before sun-rise, there not being a breath of wind, a dense white cloud of a pyramidal form was seen on the site of the Alban lake, and rising far above the highest peak of the mountain, its form gradually changed after sun-rise, its apex first disappeared, and its body, as it were, melted away in the sun-beams.

Where rivers rise from great sources in the interior of rocks or strata, as they have the mean temperature of the climate, mists can rarely form upon them, except in winter, or late in autumn, or early in spring. In passing across the Apennines, on October 1st, 2nd, and 3rd, 1818, there having been much rain for some days preceding, and the nights being very clear, I observed the beds of all the rivers in the valleys filled with mist, morning and evening, except that of the Clitumnus near its source, in which there was no mist, and this river rises at once from a limestone bed, and when I examined it, at half-past six o'clock, a.m., October 3, was 7½° lower than the atmosphere.

Great dryness in the air, or a current of dry air passing across a river, will prevent the formation of mist, even when the temperature of the water is much higher than that of the atmosphere; thus, on the 14th of June, near Mautern, though the Danube at five in the morning was 61° F., and the air only 51°, yet there was no mist; but a strong easterly wind blew, and from the rapidity with which water evaporated, it was evident that this wind was in a state of extreme dryness.

The Tiber has furnished me with a number of still more striking examples. October 19th, the night having been very clear, on arriving at the Ponte Mello, at half-past six in the morning, I found no mist on the river, yet the temperature of the air immediately above it was 48° F., and that of the river 56° F.; a strong north wind blew, which indicated, by the hygrometer, a degree of dryness of 56°, and this part of the river was exposed to it; but the valley above, where the river was sheltered from the wind, was full of mist, and the mist in rising to the exposed level might be seen, as it were, dissolving, presenting thin striæ which never reached above a certain elevation, and many of which disappeared a few seconds after they rose. From the 13th to the 25th of October, during which time the tramontane or north wind blew, I witnessed repeatedly the same phenomena, and in the whole of this time there was only one morning when there was no mist in the sheltered valley, and the cause was perfectly obvious; the night had been very cloudy, and the thermometer, before sun-rise, indicated a difference of only one degree in the atmosphere below that of the river.

It is not my intention to discuss the general subject of the deposition of water from the atmosphere in this paper; but merely to describe a local cause of considerable extent and variety in its modifications, and which is not without an effect in the economy of nature; for verdure and fertility, in hot climates, generally follow the courses of rivers, and by the operation of this cause, are extended to the hills, and even to the plains surrounding their banks.—*Philosophical Transactions.*

ON SEASONING TIMBER.

The premature decay of timber, and especially of the oak, by what is technically called the dry rot, is a subject which has occupied no small share of public attention. If we may credit all that we read and hear, the immersing of timber in Kyan's mercurial preparation is the nearest approximation to the long wished-for desideratum. Still I cannot conceal my doubts as to its general utility. Its application to timber for lighter purposes may be of much use in promoting durability; but its action on the huge timbers of even a third-rate man of war will, I fear, come infinitely short of expectation; and, indeed, I think it highly probable that after-experience will prove that, from the claims of a decided specific, Kyan's process must degenerate to the rank of an expensive auxiliary.

In all our attempts to arrest the progress of dry rot, there seems to be an obvious misdirection of inquiry; our investigations not having been yet directed to the more immediate cause of the malady. In organic bodies preventives are always preferable to cures; therefore, wherever detrimental effects present themselves, we ought at once to turn our attention to the producing cause with a view to its removal, rather than to the application of temporary palliatives. That the appearance of precocious decay in manufactured timber may be traced to the presence of alburnous matter, in its fluid state, in the sap vessels, is a fact generally admitted. When an oak tree with its vegetative powers in full operation is felled, the sap, or alburnous fluid, not having been perfected, or converted by the process of folia ceous elaboration to its ultimate purpose, becomes stagnant; putrefaction speedily commences, and in in a short time communicates with, and contaminates, the sounder parts of the fibrous column. The direct means employed by nature in decomposing vegetable matter does not appear to have received its due share of consideration from the naturalist. The agency of alburnous matter in an imperfect state is allowed; but, judging from the analogy that subsists between animal and vegetable creation, we can only view this as a secondary cause. In all bodies, whether animal or vegetable, where vitality has ceased to exist, it seems to be a universal law of nature, in the process of decomposition, to employ some active foreign power. Self-destruction forms no clause in the natural code; therefore we may rest assured that there is something else in operation, than merely the presence of simple alburnous fluid. Animal bodies contain the seeds of corruption within themselves; the different fluids teem with countless millions of animated beings. When the vital functions are brought to a close, these tiny tenants of the veins and arteries commence the work of devastation upon the more assailable matter: the putrid mass engenders animals of larger dimensions, to gnaw the sounder portions of the frame, and, shortly afterwards, the loathsome task of uniting earth to earth is accomplished.

It is possible that the decomposition of vegetable substances is performed by means not very dissimilar to that of animals. The germs of the dry rot may be communicated to the fibrous mass through the medium of the secretive organs at the root. Doubtless, the alburnous fluid is tenanted by legions of animalcul[illegible], the putrid remains of which in the sap vessels may form a soil, or bed, for the developement of the embryo fungus. Immersion in corrosive sublimate imparts no additional strength to the woody fibre, it only destroys the vitality of the matter in which the dry rot originates; and, if the foregoing remarks on the origin of the malady are based in truth, then we have within our reach agents equally, or even more, effective, and far less expensive, than corrosive sublimate. If it can be clearly proved, that unconverted sap in timber is the source of the dry rot, as already suggested, then I have succeeded recently in the inventing of a process, whereby the sap can be completely extracted from logs of almost any size. By this process (the material for the preparing of which can be had for picking up anywhere) I find that oak timber can be divested of the sap, and so seasoned, that, in less than ten hours after being cut, it may be put into the hands of the carpenter. It was my intention to apply this process to preventing the shrinking and twisting of larch timber; but I have not had an opportunity as yet of making the experiment: from what I have seen of its effects on oak, however, I entertain the most sanguine hopes of success.

An aptitude to act on superficial evidence is a fault common to our nature; and hence we are too often led to mistake effect for cause. Precocious decay, or dry rot, is an effect, in my opinion, produced in most instances by the very questionable manner in which oak timber is harvested. In felling most of the other species of hard-wood trees, it is an invariable practice to have them cut down when vegetation is in its most inert state; but, from the great value of its bark, the oak forms an exception to this most judicious rule. The process of disbarking can only be performed when vegetation is in full activity, and certainly it requires no argument to show that this, of all seasons in the year, is the most improper to fell timber of any sort, if durability is to be taken into consideration. Oak bark forms no contemptible item of our inland commerce; and to propose that all oak-trees to be applied to marine constructions should be cut down in the months of December and January, will be a startling announcement to some economical proprietors and stewards, as by such a course the value of the bark must be sacrificed; but I propose no such thing to them. Let it be remembered that I am writing with a view solely to the stability of the wooden walls of old England. I am not patriot enough to recommend individual sacrifice for the public good, when there exists no necessity for it. This is the age for "compensation;" and when, collectively, we can afford to present the West India planters with twenty millions sterling for performing one single act of justice, surely, when treating with oak-venders to furnish our timber depôts with sound material, we can well afford to make an equitable allowance for the bark, if it can be proved, as I think it easily may, that we would be gainers thereby.

All timber, then, for the use of the British navy, ought to be purchased growing, with an understanding between the contracting parties, that the vendor shall be bound to fell the trees at such seasons as may be agreed upon; namely, in the months of December or January. Had some such plan as this been adopted long ago by the officers of the public dockyards, it is my firm belief that dry rot would have been much less prevalent. Even the process of felling herein recommended is susceptible of improvement. Where any large oak tree fit for naval purposes is sold, it might be arranged that the purchaser should be allowed two, three, or more, years to remove it. In this interim, vegetation might be gradually retarded, by severing from the main root, annually, so many of the principal lateral roots, until the foliage all but refused to expand. Under this treatment the usual copious flow of sap would be diminished; and, by reducing the medium of its ascent annually, the fibre would become seasoned, and would acquire a rigidity and toughness not obtainable under the old regimen.

Castle Ashby. J. MUNRO.

PETRIFIED HUMAN BONES.

Dr. Lund, now residing at Lagoa Santa, in Brazil, states that upon a late journey into the interior of Brazil, he had, for the first time, met with human bones, in conjunction with the bones of acknowledged extinct animals, which must be of an extraordinary antiquity, perhaps the oldest human bones that have ever been found; for they are in part petrified, and in their preserved condition altogether correspond with those of the extinct animals, in connexion with which they were found. They will, he observes, throw a light on the nature of the inhabitants of this part of South America, in times which go much farther back than our knowledge of this part of the world. The formation of the cranium is extraordinary, inasmuch as the forehead does not rise in the same plane with the face, but forms a considerable angle, by which peculiarity they differ from all craniums of living races of men, and resemble the depressed heads represented in the ancient drawings of the Mexicans. In connexion with the extraordinary bones, was found a hemispherical-shaped stone, quite polished on the under surface, which had evidently been used for rubbing.

MEDICAL RECEIPTS.

FOR THE TEETH.

Hudson's Preservative consists of equal parts of the tincture of bark, myrrh, and cinnamon, with a little gum arabic.

Rennie's is made by mixing 4 grains of chlorinated lime (chloride of lime) with 2 drams of powdered gum or red coral; this is recommended as a sweetener of the breath, and to take off yellowness from the teeth.

Greenough's Tincture.—Take 2 ounces of bitter almonds, half an ounce each of Brazil wood and cassia berries, 2 drams of Florentine orris root, 1 dram each of binoxalate of potass, alum and cochineal, half an ounce of spirit of horse-radish, and 2 pints of spirits of wine.

Green's Tooth-powder.—Take 1 ounce each of dried sage leaves, crust of bread, and chloride of sodium, and 1 dram each of nutmeg and cloves powdered; triturate and mix in a mortar.

Russini's Tincture for the Teeth.—Take 8 ounces of Florentine iris root and rhatany root, 1 ounce of cloves, 1 scruple of ambergrise, 2 grains of musk, 2 pints of spirits of wine; make a tincture and apply it with a bit of sponge or cotton. It is not so good as tincture of myrrh.

Delescott's Myrtle Opiate.—Simmer 2lbs. of honey with half a pint of rose-water in an earthen vessel over a slow fire, for a few minutes, and then mix it with a tooth-powder prepared from myrrh and Armenian bole, into a soft paste. It is laid on with a brush and is good for sweetening the breath.

Parisian Dentrifice.—Take 4 ounces each of powdered Florentine iris and Peruvian bark, 12 ounces of prepared chalk, (whiting,) 1 ounce of myrrh, 1 ounce and a half of rose-pink, and 16 drops each of the oils of cloves and of cinnamon.

Barker's Tooth Tincture.—Take any quantity of alcoholic infusion of pyrethrum, (feverfew) and color with tincture of red cabbage.

Laennic's Remedy for Tooth-ache.—Mix 1 dram of creosote and 1½ drams of spirits of wine; to be applied on cotton wool.

Mineral Metallic Cement.—An amalgam of tin foil and quicksilver, combined with iron filings, finely levigated for filling decayed teeth.

Le Dray's Marmoretum.—An amalgam of tin foil with quicksilver, combined with some very finely powdered flint glass.

Mallan's Succedaneum is nearly the same as the tin-foil on the back of looking glasses. It may be made by rubbing together quicksilver and tinfoil in a mortar, or melting them together in a ladle over a fire, and applying them while warm. It grows harder by degrees as the quicksilver becomes absorbed.

Lardner's Prepared Charcoal.—Chalk, colored grey with charcoal.

Grosvenor's Tooth-powder.—Rose-pink 3lbs., pulverized orris root ½lb., oyster shells 3lbs., oil of rhodium 25 drops.

Asiatic Dentifrice.—Powdered red coral 8 ounces, Venetian red 6 drams, red ochre and pumice stone each 1 ounce, musk ½ dram.

Hemet's Dentifrice.—Cuttle fish bone ½lb., cream of tartar ¼lb. orris root 2 ounces.

Green Tooth-powder.—Dry sage leaves, toasted crust of bread, and common salt each 1 ounce, nutmeg and cloves each 1 dram.

DEPILATORIES;

OR, COMPOSITIONS TO TAKE OFF SUPERFLUOUS HAIR.

Take of quicklime 1lb., orpiment 3 drams, orris root 2 drams, saltpetre 1 dram, sulphur 1 dram, soap-lees half a pint; evaporate to a proper consistence.

Roseate Powder.—Lime 12 ounces, starch 10 ounces, orpiment 1 ounce; mix them together.

Boyle's Depilatory.—Take equal parts of orpiment and quicklime, powder them separately and dissolve them in water till they form a thick paste. This is laid over the part whence the hairs are to be removed, and afterwards wiped off with a wet cloth.

Strong Depilatory.—Take 1 ounce of gum ivy and 1 dram each of orpiment, ant's eggs, and gum arabic reduce to powder and make into paste with vinegar.

Turkish Depilatory.—Take 5 ounces of quicklime and 1 ounce of orpiment, reduce them separately to fine powder, mix well and sift. If too strong add 1-seventh or 1-eighth of starch powder; form into a paste with warm water, and apply as before.

Delecroix's Depilatory, or Poudre Subtile; and *Colley's Depilatory*, composed like the rest of quicklime and sesqui-sulphuret of arsenic (orpiment) perfumed with orris root powder and tempered with starch.

[It is to be remarked that the use of all depilatories is attended with danger, as it is by the absorption of the very poisonous sulphuret of arsenic, that they produce the effect expected from them.—*Ed.*]

HAIR DYES, &c.

Essence of Tyre is merely a solution of nitrate of silver, (lunar caustic.)

Grecian Water, or Hassan's Dye, is a solution of nitrate of silver, colored with syrup of buckthorn.

Orfila's Hair Dye.—Plumbite of lime, made by boiling for an hour and a quarter 4 parts of sulphate of lead, with 5 parts of slaked lime, and 30 parts of water, filtering the liquor, and collecting the powder. This, in a warm solution, will dye the hair a fine black in one hour.

Ure's Dye.—Dr. Ure recommends a paste made by mixing litharge, slaked lime, and bicarbonate of potass, (pearl-ash) in various proportions, according to the shade of color desired; he states also that the salts of mercury, lead, bismuth, as well as their oxydes, blacken hair, by the formation, most probably, of metallic sulphurets.

Fox's Cream for the Hair.—Put into a jar 2 ounces each of marrow pomatum and almond oil, melt gently by the fire, and while cooling, stir in 2 drams of oil of jessamine or bergamot.

Rowland's Essence of Tyre is also a disguised solution of nitrate of silver.

Rowland's Macassar Oil is made by boiling any rancid oil with onions or garlic, to take off the bad smell, and scenting with oil of roses, and coloring while warm with alkanet root.

Note.—We intend to give each month a collection of little-known and valuable receipts, similar to the above.

Vols. 1 and 2 of this Magazine are now ready, elegantly bound in Cloth and Lettered, price 9s. each.

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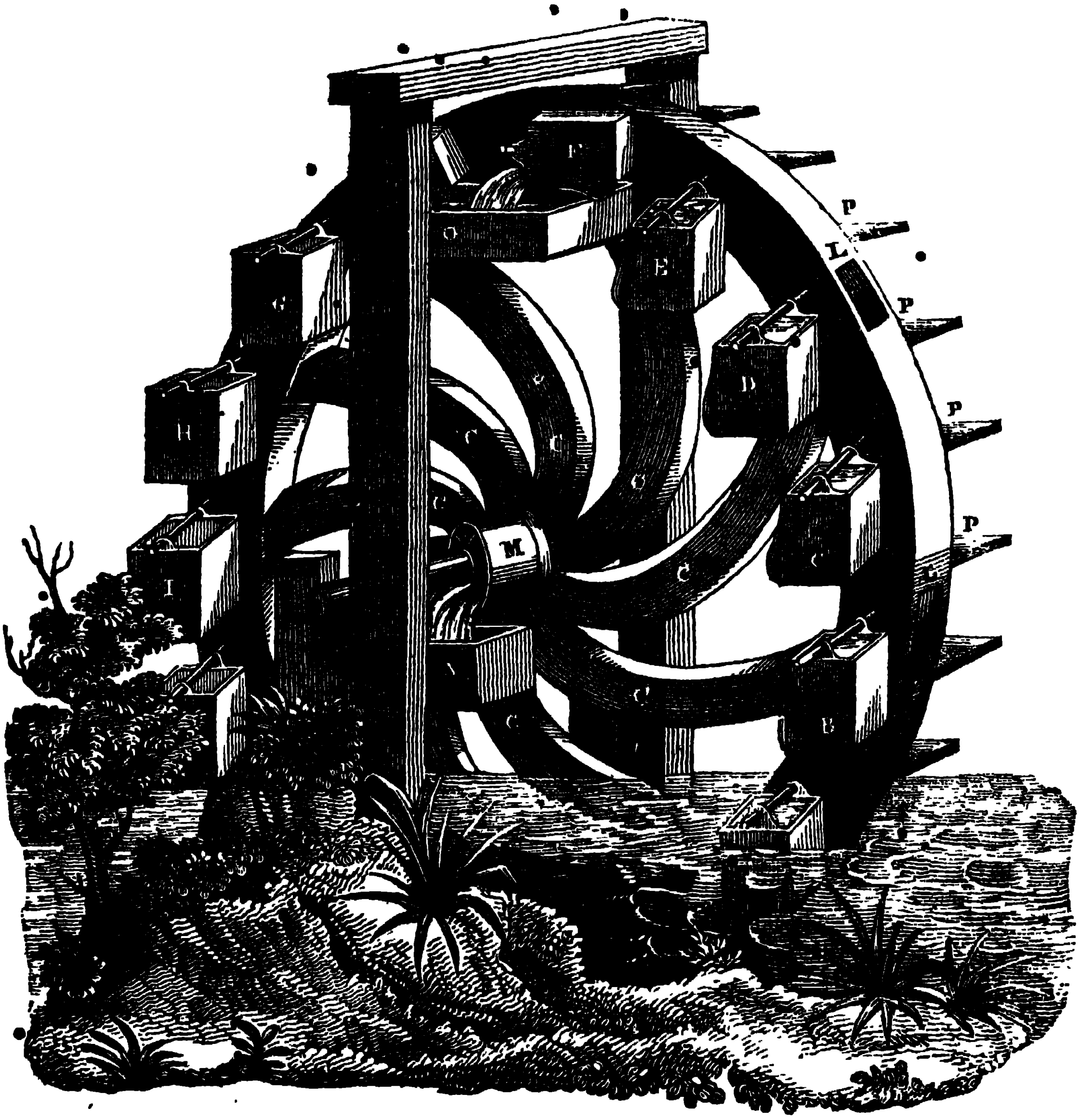

HYDRAULIC ENGINES.

Having considered in a former paper those hydraulic engines which act by the pressure of the atmosphere, commonly called pumps, it is advisable to direct a little attention to the most remarkable of those which act by mechanical means only.

Of these, one of the most ancient, as well as one of the most effective, was the *tympanum*.

It consists of a great hollow wheel, composed of several planks joined together, and well calked and pitched, forming, as its name imports, a kind of barrel or drum, and having a horizontal axle on which it turns. The interior is divided by eight partitions into as many equal spaces or cells, each of which has an orifice of about half a foot in the rim of the drum or wheel, shaped so as to facilitate the admission of the water: there are, moreover, eight hollow channels running contiguous to each other and parallel to the axle of the wheel, each corresponding to one of the eight large cells, through which the water passes from the cells just mentioned, and after running along the channels to a convenient distance, escapes through orifices into a reservoir placed just beneath the axle of the wheel. Thus the water is elevated through a vertical space equal to the radius of the hollow wheel. When the tympanum is used to raise water from a running stream, it is moved by means of float-boards impelled by the stream; but when employed to raise stagnant water, it receives motion from a foot-wheel placed on the same shaft, turned by men walking inside. The chief defect of this machine is, that it raises the water in the most disadvantageous situation possible: for the load being found always towards the extremity of a radius of the wheel, the arm of the effective lever which answers to it, increases through the whole quadrant the water describes in passing from the bottom of the wheel to the altitude of its centre; so that the power must act in like manner as if it were applied at a winch-handle, and consequently, cannot act uniformly.

M. de la Faye, to remedy this defect, devised a machine which may here be described, together with the process of reasoning that led to it.

When we develope the circumference of a circle, a curve is described (*i. e.*, the involute) of which all the radii are so many tangents to the circle, and are likewise all respectively perpendicular to the several points of the curve described, which has for its greatest radius a line equal to the periphery of the circle evolved. The truth of which is shown by geometricians when treating of the genesis of evolute and involute curves.

Hence, having an axle whose circumference a little exceeds the height which the water is proposed to be elevated, let the circumference of the axle be evolved, and make a curved canal whose curvature shall coincide throughout exactly with that of the involute just formed: if the further extremity of this canal be made to enter the water that is to be elevated, and the other extremity abut upon the shaft which is turned, then, in the course of the rotation, the water will rise in a vertical direction, tangential to the shaft, and perpendicular to the canal in whatever position it may be. Thus the action of the weight answering always to the extremity of a horizontal radius, will be as though it acted upon the invariable arm of a lever, and the power which raises the weight will be always the same: and if the radius of the wheel, of which this hollow canal serves as a bent spoke, is equal to the height that the water is to be raised, and consequently equal to the circumference of the axle or shaft, the power will be to the load of water reciprocally as the radius of a circle to its circumference, or directly as 1 to 6¼ nearly.

In M. de la Faye's opinion, the machine ought to be composed of four of these canals; but it has often been constructed with eight, as represented in our figure. The wheel being turned by the impulsion of the stream upon the float-boards, the orifices L L, &c., of the curvilinear canals, dip one after another into the water which runs into them; and as the wheel revolves, the fluid rises in the canals, C, C, C, C, &c., and runs out in a stream M from the holes at N; it is received into the trough, and conveyed from thence by pipes.

By this construction the weight to be raised offers always the same resistance, and that the least possible, while the power is applied in the most advantageous manner the circumstances will admit of. As in many cases water is to be raised higher than the radius of any wheel that can well be made, we shall describe a machine called the *Persian wheel*, which, like the machine of M. de Faye, may be turned by means of a stream of water acting upon the float boards of the wheel. It, had, however, the disadvantage attending the tympanum, which is, that it can only raise water to the height of its semi-diameter.

The buckets B C D E, &c., are *hung* upon the wheel by strong pins, fixed in the side of the rim; which must be made as high as the water is intended to be raised above the level of that part of the stream in which the wheel is placed. As the wheel turns, the buckets on the left hand go down into the water, where they are filled, and return up full on the right hand, till they come to the top at F; where they strike against the end of the fixed trough O, by which they are overset, and so empty the water into the trough; from whence it is to be conveyed in pipes to any place it is intended for: and as each bucket gets over the trough, it falls into a perpendicular position again, and so goes down empty till it comes to the water at A, where it is filled as before. On each bucket is a spring, which going over the top or crown of the trough O raises the bottom of the bucket above the level of its mouth, and so causes it to empty all its water into the trough.

DISTRIBUTION OF ANIMALS.

(Resumed from page 4, and concluded.)

The particular or local distribution of animals is affected by various causes which have little influence on their geographic distribution. Thus the purely insectivorous birds of the family sylviadæ feed on all small kinds of insects, without regard to any particular species; yet the sylviadæ of America and those of Europe are each characterized by a peculiarity of structure which invariably designates the continent to which they belong. The wryneck is represented in America by the oxyrhynchus cristatus; yet neither of these birds is found to inhabit all parts of their respective continents: their range, on the contrary, is regulated by temperature, food, and other circumstances connected with local distribution.

From temperature originate all the causes which affect local distribution, namely, food, situation, and migration. Were the climate of this country as unchanging as that of Brazil, the insects which now have only a single brood in the year might then produce several, and the swallow would no longer be obliged to quit us as now, for food in other climates, as soon as our insect season was at an end. Migration and torpidity are equally the effect of temperature; the first depends upon the effect which the changes of the seasons produce in the abundance or scarcity of food, whether animal or vegetable; the latter is a state of inaction during which the necessity for daily nourishment is suspended.

The migration of birds and of fish is more extensive than that of quadrupeds. The birds of the Polar regions migrate to Britain during severe winters; while those of Africa come to us, in that season when the southern heats are most intense; but the same species which is migratory in one country is in some cases stationary in another. It is stated that the linnet is migratory in Greenland, but that it is stationary in Britain.

The torpidity or hybernation of animals is evidently designed to suspend the necessity of taking food during the winter; although in some cases a small stock of provisions is laid up, most probably to serve for nourishment previously to entire torpidity taking place. Several quadrupeds are subject to this partial suspension of life, as the dormouse, hedgehog, bat, marmot, &c. It is said that birds have sometimes been found in a similar state; but this is very questionable. Among insects, on the contrary, torpidity is very common, and a large proportion, when undergoing transformation, pass a considerable part of their lives in this state.

Situation has an extensive influence on the local distribution of animals, although it has little on the geographical distribution of groups. Air, earth, and water, have their distinct inhabitants, which are again restricted to certain situations in their respective elements. The higher regions of the air are frequented by the eagle and falcon tribes; the middle by the air-feeding birds; and the lower by insects which merely jump, or just fly above the ground. The different situations on land, as mountains, plains, woods, marshes, and even sandy deserts, are each peopled by distinct races of beings, whose subsistence is sought for and furnished in peculiar spots. Thus the range of any particular species is seldom or never continuous, or uninterrupted to its confines; but is rather dependent upon local causes, quite unconnected with geographic division. Water is either the total or the partial residence of animals innumerable; but here situation has an equal influence; the deeps and the shallows of the ocean, its exposed or sheltered shores, its sandy, rocky, or muddy bottoms, are each the resort of different beings, widely distinct from those residing in the streams, lakes, rivers, and estuaries of fresh waters. It is principally among insects that we find the perfect animal inhabiting a situation different from that which was essential to its existence in an imperfect state. The larvæ of the May-fly, known to the vulgar by the name of case-worm (trichópteræ,) and of all the libéllulæ live entirely in the water, preying upon other aquatic insects; but as soon as the period of transformation arrives, they crawl on the plants, just above the surface, and bursting the skin, become winged insects, which immediately commence an uninterrupted war upon others in their new element. The larva of the well known ephémera is likewise aquatic, and spends nearly all its life in water; but the perfect insect is without jaws, mounts into the air, and seems born but to flutter and die. Many of the coleóptera pass the first period of their existence entirely underground, others in the trunks of trees; and others again in putrid substances; situations very different from those which they frequent when arrived at maturity. Lepidopterous insects, after emerging from the eggs, undergo three changes, all of which are in situations totally opposite. In the larva state they reach their full dimensions by feeding upon the leaves of vegetables; they next pass into pupæ, and become torpid either above or beneath the surface of the ground; from which they emerge, and again become inhabitants of earth and air as perfect winged insects.

The rapacity of carnivorous animals has been considered by some writers to have had a considerable effect on the distribution and even on the extinction of others; but no instance has yet been brought forward in support of this argument, nor does history furnish us with any proof of such having been the case. The fossil remains of those stupendous carnivorous animals which have been discovered of late years, and which existed in the antediluvian world, might have suggested this idea as probable, and that the destruction among a host of smaller animals which would alone have satisfied the hunger of a brood of lizards (like the plesiosaúrus) forty feet long and six feet high, would soon have extirpated whole tribes; but it must not be forgotten that these gigantic animals belonged to a different creation from that which now covers the earth; and that neither in Africa or in India, where the present races of carnivorous animals are most abundant, has any change or sensible diminution taken place in the proportion of those upon which they principally feed.

Man alone has exercised, in various ways, a powerful influence on animals, and on their distribution: these changes, however, are purely artificial; they have caused the partial or total extinction of some species, and the extension and domestication of others. Against many, hostile to his interests, man carries on a war of extermination, which, as population spreads, is at length effected in particular countries. The wolf, once so abundant in Britain that their heads were received as tribute by our Saxon kings, has for centuries been extirpated from our forests; and a progressive decrease is continually going on among the wild animals, not only of Europe, but of North America. Others, inoffensive in their habits, but valued as food, have been driven from our island. The egret and crane, as British birds, are no longer known; while the great bustard, which may be called the ostrich of Europe, is now rarely seen; and in all probability (unless its name should be inserted in the game laws) will be totally lost to us in a few years. In like manner that extraordinary bird the dodo (which was the ostrich of Asia) has not been seen for more than a century, and may possibly be no longer in existence. The benefits that have resulted, on the other hand, from the extension and domestication of useful animals, are sufficiently known. All the various breeds of our domestic cock have originated from the forests of India, which have likewise furnished Europe with the pheasant and the peacock; the pintado or guinea fowl is of African origin; the horse and domestic ox were unknown in the new world before its discovery by the Spaniards; and the vast island of Australia has been supplied with all its domestic animals from Europe. The turkey is of American origin; and, although nearly extinct in its native forests, is domesticated all over the world. There are doubtless many other animals that might be domesticated, either for use or pleasure; but in a country like this, so variable in its climate, and where land is so valuable, it is much to be feared the necessary experiments will not be made.

The local distribution of British animals, however interesting, is too confined a subject to lead to any general or important conclusions regarding the geographic distribution of animals. It is, however, an inquiry that merits attention; and although no one has yet expressly written upon the subject, the observations of White, Montague, and several others, will furnish a great deal of valuable information. In arranging the British fauna, all such birds as have been seen apparently as wanderers, and only at long intervals of time, should be excluded, or at least distinctly noticed as accidental visitors; but to introduce the peacock, the domestic cock, and the turkey, into a natural history of British birds, as some have done, is a manifest absurdity; for upon this principle we should include the canary, the gold and silver pheasant, and all other exotic birds which may have accidentally bred in our aviaries.

BOTANICAL NOTICES.

SEEDS AND THEIR APPENDAGES.*

The usual structure of a seed can be perceived easily in a bean or pea, as taken from the pod. Looking at this before breaking it to pieces, a *scar* will be observed on one side, where it was joined to the pod or grew in—this is called the *hilum* or *eye*, and is only apparent on the outer coat, called the *testa* or *skin*. The testa being removed, the

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* We are permitted by the author to extract the following from the Grammar of Botany, published at 4s., by W. Brittain. London, a work which we can strongly recommend to our readers.

embryo or *kernel* is visible—this consists of two *lobes* or *cotyledons*, attached to each other by a heart-shaped body, called the *corculum*—the lower end of which, the *radicle*, produces the future root, and the upper end or *plumule* the future stem, while the lobes give the first nourishment to the young plant.

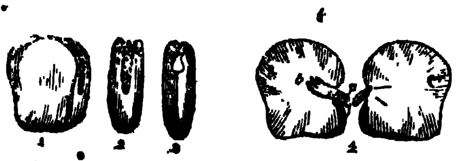
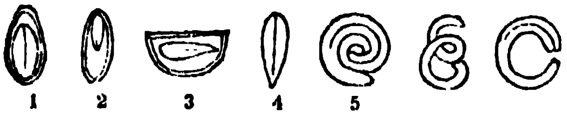


Fig. 1. Side view of a Bean 2 End view of ditto. 3. The same view, the coat of the seed being removed. 4. The same opened, showing the two lobes, the radicle (A,) and the plumule (B.)

In some seeds, besides the embryo, there is a portion which when young is fluid or pulpy, and is intended to nourish the seedling plant, in the same manner as the white of an egg nourishes the young chicken, and which is therefore called *albumen.* Sometimes the albumen is wholly absorbed during the ripening of the seed; in other cases it is found afterwards as a nut-like, horny or mealy substance. Thus almost the whole of a grain of wheat is albumen—so is the hard stone of the date, and the flesh of the cocoa nut. In the last instance part of the albumen remains fluid, which we know as the milk of the fruit. A thin skin, called the *membrane*, is also found sometimes within the testa, as in the walnut; and in many instances an extra coat envelopes it—this is called the *aril.* The bean above represented has neither albumen nor aril. The nutmeg seed has both: the mace is the one, and the round aromatic part, commonly known as the nutmeg, is the other—the embryo being exceedingly small.

Of the various parts of a seed the embryo is the most essential, as it is this which grows into the future plant, and without which no seed is perfect, however well formed it may appear. The embryo is sometimes erect (1) as in the dandelion and other compound flowers; reversed or hanging by the upper end (2) as in parsley, and the rest of its order; or hori[illegible] (3) as in the primrose. Its particular shape v[illegible] materially: it may be straight (4)—coiled up (5)—spiral (6)—annular (7)—or bowed, bent, and plaited in various ways.

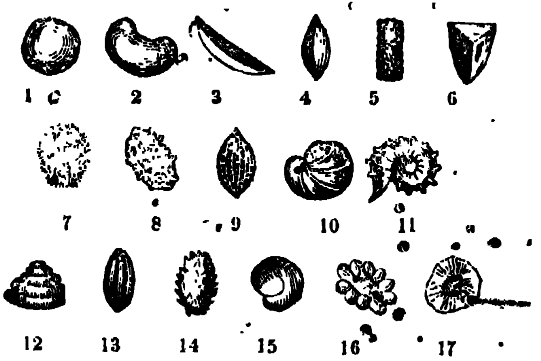


1. Embryo of Dandelion. 2. Ditto of Parsley. 3. Ditto of the Primrose. 4 Ditto of the Arum. 5. Ditto of the Hop. 6 Ditto of the Dodder. 7. Ditto of the Lychnis, the Spinach, and very many other genera of plants.

Such seeds as agree with the above description in having two cotyledons opposite to each other; also those few plants which have more than two are called *dicotyledonous*; but there are others which are never found with more cotyledons than one, (or if there are more, they are not opposite to each other,) such, for example, as the grasses and the lilies. These plants are called *monocotyledonous*, while the flowerless plants, having no cotyledon at all, are called *acotyledonous*. It is in botany of the first necessity to pay attention to these three words, because the plants of the one or other kind have such very different characters of leaves, stems, and general structure, that the foundation of the whole arrangement of plants in natural orders depends upon these differences.

In the color of seeds almost every tint may be found. Various shades of brown, red, and straw color, are common—black and white scarcely less so. Brilliant yellows, blues, purples, and greens, are more rare; but bright scarlets, crimsons, and delicate flesh colors occur frequently, while many are most beautifully mottled and speckled—an instance of which we see in the different varieties of the French bean.

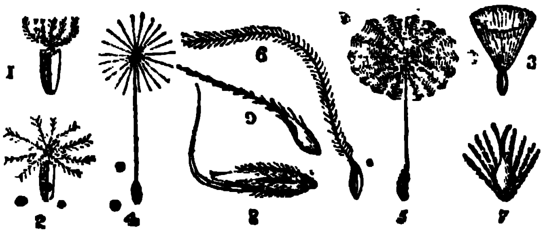
The shape of seeds is no less varied. They may be globular, flat, oval, tear-shaped, and of almost every solid form, as will be seen by the following engravings:—



1. Seed of the Pea. 2. Of the Kidney Bean. 3. Of the Tofieldia Palustris. 4. Of the Flax. 5. Of the St. John's Wort. 6. Of the Pansey. 7. The hairy seed of the Rose. 8. Pitted seed of the Snap-Dragon. 9 Of the prickly Poppy. 10. Shell-like seed of the Cinque-Foil. 11. Seed of a Brazilian Plant. (the Physostomon.) 12. Seed of the Salsola Kali. 13. The ribbed seed of the flowering Rush. 14. The rough seed of the Frog Bit. 15. Seed of the Beet Root. 16. Seed of one species of the Loosestrife. 17. Winged seed of the ten-week Stock.

It will be seen from the above how the surface of seeds is variously marked and roughened—and, as in the rose tree, covered with hairs. In the cotton tree they are enveloped in the fine, long, and white down, which is so well known as cotton; and if we consider still as seeds, rather than as seed-vessels, what are commonly called such—namely, the produce of the grasses, the compound flowers, the umbellate plants, and some others, we shall not only greatly increase the number and variety of shapes which they assume, but have our attention directed to sundry curious appendages, by which the dispersion of seeds is in numerous instances assisted.

The seeds of many plants have attached to them feathery crowns, called in the singular a *pappus*. In the valerian it at first remains carefully coiled up, but as the seed ripens it expands, and the seed is carried away; when it finds a moist spot adapted to its growth this beautiful little crown falls off. From the seeds of the willow herb the crown of hairs projects like the feathers of a shut[illegible]cock, opening afterwards like a star. In the dandelion this pappus is supported upon a stalk, which elevates it above the seed. In the goat's-beard not only is this the case, but each fine hair is itself a feather—forming altogether one of the most elegant and perfect objects. All these contrivances are intended to catch the wind, that the seed may be wafted to a distance. The same purpose is accomplished in the feather grass, in the clematis, and still more perfectly in the tillandsia, a plant of tropical countries, by a long feathery awn. The seeds of many of the grasses and such like plants have attached to their lower end, strong and stiff bristles, called *setæ*. These pointing all one way prevent the seed returning, when by any cause it has worked itself along the ground, or among the clouds. This motion is often occasioned by change of dryness and moisture in the air. The animated oat (avena fatua and sterilis,) is a well-known example of it. If one of these seeds be placed upon a shelf or window sill in changeable weather, it will, after the lapse of two or three days, be found to have crawled forwards to a considerable distance from its first situation, as follows:—When the seed becomes damp, it swells and lengthens. When the air dries it again, it becomes shorter, but on account of its setæ, it cannot return;* therefore it draws the latter end along, and thus at every change in the weather it moves a step forward.



[illegible] 2. Pappus of the Valerian. 3. Ditto of the Willow Herb and the Groundsel. 4. Ditto of the Dandelion. 5. Ditto of the Goat's Beard. 6. Feather of the Clematis Seed. 7. Setæ of the Scirpus, or Bull Rush. 8. Hairs of the Animated Oat. 9. Awn, or toothed bristle of the Barley Grass, the teeth being magnified.

This is the case too with the *awn* or beard of barley and wheat, which are set with teeth like a saw, and not merely the seeds of these plants, but the whole *ear* will crawl away from its parent, if broken off: as is well known to children, who gather the *ears* of the common barley grass, and putting one end up their sleeve, at the wrist, soon find it at their shoulder.

Besides these admirable contrivances for the dispersion of seeds, there are many more to be looked for in the elasticity and peculiar formation of seed-vessels. Animals often assist in accomplishing the same purpose—their fur and wool catches the hooks with which the seeds of the goose-grass are provided; while those of the mistletoe adhere to whatever may touch them, owing to their clamminess. It is well known also, that the seeds of numerous berries and small fruit will grow, though they have passed through the bodies of the birds which have swallowed them. Thus we not only witness in seeds themselves the most admirable structures and contrivances for their well-being, but the very habits and necessities of animals are made subservient to the more general dispersion of the vegetables upon which they are fed and nourished.

[illegible] EVER-BURNING FLAME.

A [illegible] lately read at the Royal Irish Aca[illegible] Mr. G. J. Knox, 'On a Principle for producing an Ever-burning Flame.'—" A belief," he observed, " in the discovery of an ever-burning lamp appears to have been prevalent in all ages; and tradition informs us, that lamps have been found in tombs, where they have continued burning for upwards of a thousand years, of which mention has been made in the works of St. Austin, Plutarch, Pliny, Ludovicus Vives, Baptista Porta, and Licetus. The Rosicrucians, who laid claim to the knowledge of everything mysterious, pretended to have re-discovered the secret of their construction, which was supposed to have been buried in the tomb of their founder. Dr. Plott, in a treatise which he has written upon this subject, alludes to a lamp mentioned by St. Austin in his book de Civitate Dei, which was hung up in the temple of Venus; and to another found in the tomb of Pallas the Arcadian, who was slain by Turnus in the Trojan war, which continued to burn after its removal from the tomb and exposure to the air—proving that these lamps were not supplied from any bituminous source, or volcanic fire. He considers the requisites for an ever-burning lamp to be—a perpetual wick, which might be made of gold wire, or asbestos; and a perpetual supply of fuel, which he imagines the bituminous springs of Pitchford, in Shropshire, or the inflammable gases issuing from fissures in coal mines, would afford. That such could supply fuel for a flame, so long as the bituminous spring existed, or the gas continued to exhale from the mines, is evident; but it no more deserves the appellation of an ever-burning lamp, than does a fire arising from any volcanic source. The desideratum for such a lamp is, that it should contain, within itself, a renovating principle, such as, probably, does the luminous atmosphere encompassing the body of the sun, supposed by Sir William Herschel to be electrical. That electricity was the principle upon which such a lamp could be constructed, having occurred to me some years ago, I reflected upon the different means by which a constant light could be produced from this source, and concluded that, if by an arrangement of metals a thermo-electric current could be produced of sufficient intensity to decompose water, the heat produced by the burning of the two gases arising from the decomposition, would be sufficient, when applied to the alternate metallic junctions, to continue the electrical current of the thermo-electric pile; while the gases, which, in burning, become aqueous vapor, might be condensed by passing through a long tube, through which, being conveyed to the closed vessel in which the water had been originally placed, they would again undergo decomposition, recombination, and condensation. Such a thermo-electric arrangement has been discovered by Professor Botto, of Turin, who has obtained decomposition of water from a series composed of a greater number of wires of platinum and iron. To prevent the apparatus from acquiring in time the same temperature, the alternate junctions of the metals, to which the heat is not applied, might be connected with the pedestal upon which the lamp is placed; and the pedestal be either allowed to rest in a cold situation, or else be connected by wires with some extensive cooling surface."

CHARCOAL AS A MANURE.

BY MR. LUCAS, BOTANIC GARDEN, MUNICH.

ACCORDING to my promise, I now lay before my readers the experiments I have made in the application of charcoal to another purpose, viz. using it as a mixture with various sorts of earth. It showed here also the same extraordinary effect; and all the plants that have hitherto been subjected to this treatment have been as much distinguished by their luxuriance of growth, as by the more perfect developement of their individual parts. This was particularly the case with tuberous-rooted plants, which, besides their perfect developement, had also a much longer period of vegetation; so that the difference in this respect, between those that were cultivated in their usual soil and those which had a mixture of charcoal, amounted to nearly two months. I was led to this by several trifling circumstances.

A very suitable treatment introduced into this botanic garden of plunging pots with bulbous or tuberous-rooted plants taken up every year, for a few weeks after potting, or till they begin to shoot, in a moderate hot-bed, covering them an inch deep with earth, was applied the previous year. A bed which had been used for sowing the seeds of tender plants in pots, and in which charcoal ashes were used for plunging them in, was appropriated to receive the newly-planted species of *A'*rum, Begònias, Gésnera, Gloxínia, and Scitamíneæ. The pots with these tubers were plunged to the rim in the frame containing the charcoal ashes, and then covered over with loose mould from a dung bed.

Before I proceed further, I cannot refrain from recommending this method, which, to my knowledge, has not been long known in German gardens, to all cultivators; for nothing is more contrary to the nature of those plants, than to set them in the open greenhouse to make their first shoots, where they are consequently in a dry situation. Most of them, when treated with a gentle equable warmth, like that of a previously-used dung bed, will be much more fine than if placed in a higher and drier temperature. Watering the tubers before they begin to grow is very disadvantageous, and yet it would be absolutely necessary if the pots stood in a greenhouse: we prevent the evil by making the earth in which the tubers are to be set sufficiently damp, only slightly pressing them down, and immediately covering them with earth in the dung bed. Only when the latter begins to dry, it should be moistened all over with the watering-pot; and this operation should be continued till all the tubers have made shoots, and then each can be watered singly. With respect to preserving them through the winter, I have to observe that these tubers, as soon as they are taken in, should be placed in the greenhouse, not too near the glass, and the earth covered with moss, by which they will be prevented from drying up too soon, and the necessity of moistening the earth obviated. By such treatment, want of success in the cultivation of these splendid ornamental plants can never be complained of. But to our subject.

These tubers, plunged in the ashes, soon shot up vigorously. As they ought to be grown in a high frame in summer, but which could not be immediately prepared, they remained in this low bed, which was only raised, dug up, and kept covered with earth. They absorbed a great deal, and required watering every day. When they were taken up, most of the roots, as may be supposed, had grown over and under the pots; they had penetrated into the charcoal, and grown so strong, that it was absolutely necessary to re-plant the tubers in pots considerably larger in size. I, of course, mixed charcoal with the earth in which they were to be planted, in the proportion of rather more than half. All the above-named species showed extraordinary luxuriance under this treatment; some were particularly rich in their inflorescence, and the green of their leaves was much more intense; in others, the period of flowering was of unusually long duration, so that while others planted in the usual soil had long ceased flowering, these continued to vegetate freely. Very small tubers, from which in the first year no flower was to be expected, flowered very beautifully, as was the case with Gésnera atrosanguínea. The *Aröídeæ*, namely those with spotted leaves, such as *Calàdium* píctum, *C.* bícolor, *C.* díscolor, *C.* spléndens, *C.* pœ'cile, *C.* hæmatostígmum, *C.* versícolor, &c., excited universal admiration. Several species of Billbérg*ia* and Tillánd*sia*, to which I also added charcoal, soon exceeded in luxuriance those that were growing in common earth. From what was before said of the *Cácti*, it may easily be supposed that they would flower well in a mixture of charcoal, which experience confirms. Héch*tia*, stenopétala, which rooted so quickly as a cutting, has since thriven equally well in a mixture of charcoal. The splendid Mexican euphorbias, such as *E.* fastuòsa and *E.* fúlgens, showed a very considerable power of growth. Orange trees with yellow leaves, having had a layer of charcoal laid on after the upper surface of earth had been removed, soon recovered their green color; this was also the case with gardenias. We need not be very particular as to the quantity to be used, half charcoal may be used without injury; only care must be taken, as before noticed, that the charcoal should be exposed for a time to the influence of the weather, and the larger pieces removed; and watering should never be neglected, as the greater porosity of earth causes it to dry up sooner.

A very interesting circumstance took place with an old and very sickly plant of the Doryánthes excélsa. After this plant had been falling off for two years, and in reality had no roots but one old and decayed one, it was planted in charcoal, and in the course of three weeks it began to shoot, and is since perfectly recovered; it is growing in a soil of one-third charcoal.

Ferns sown on fine sifted charcoal germinate quickly and well; a number of species come up in the charcoal beds where seed falls, and not only Gymnográmma macrophylla, and Ptèris serrulàta, but other rarer and more valuable species.

A friend of mine in the neighbourhood of Munich uses charcoal ashes for mixing instead of sand, and he assures me that all plants, chiefly hothouse ones, and among the cassias, particularly those with pinnated leaves, acacias, bignonias, &c., succeed extremely well, and have recovered wonderfully from their previous sickly state.

My esteemed principal, the court gardener, M. Seitz, who acknowledges the importance of this use of charcoal, is now putting in practice a number of systematic experiments with different sorts of charcoal, on all the families of plants, and it will only be at the conclusion of these extensive observations, which in spring are to be extended to garden beds, that a well-grounded opinion on the application of charcoal ashes in general can be formed.

Gartin Zeitung, for 1841.

CASSAVA.

CASSAVA bread, conaque, &c., are diff[illegible]es given to the starch of the root of t[illegible] (*Jatropha Manihot*, Linn.) prepared in [illegible]ing manner in the West Indies, the tropical regions of America, and upon the African coast. The tree belongs to the natural family of the *euphorbiaceæ*.

The roots are washed, and reduced to a pulp by means of a rasp or grater. The pulp is put into coarse strong canvas bags, and thus submitted to the action of a powerful press, by which it parts with most of its noxious juice, (used by the Indians for poisoning the barbs of their arrows.) As the active principle of this juice is volatile, it is easily dissipated by baking the squeezed cakes of pulp upon a plate of iron. Fifty pounds of the fresh juice, when distilled, afford, at first, three ounces of a poisonous water, possessing an intolerably offensive smell; of which, thirty-five drops being administered to a slave convicted of the crime of poisoning, caused his death in the course of six minutes, amid horrible convulsions.

The pulp dried in the manner above described, concretes into lumps, which become hard and friable as they cool. They are then broken into pieces, and laid out in the sun to dry. In this state they afford a wholesome nutriment, and are habitually used as such by the negroes, as also by many white people. These cakes constitute the only provisions laid in by the natives, in their voyages upon the Amazons. Boiled in water with a little beef or mutton, they form a kind of soup similar to that of rice.

The cassava cakes sent to Europe, (which I have eaten with pleasure,) are composed almost entirely of starch, along with a few fibres of the ligneous matter. It may be purified by diffusion through warm water, passing the milky mixture through a linen-cloth, evaporating the strained liquid over the fire, with constant agitation. The starch dissolved by the heat, thickens as the water evaporates, but on being stirred, it becomes granulated, and must be finally dried in a proper stove. Its specific gravity is 1·530—that of the other species of starch.

The product obtained by this treatment is known in commerce under the name of *tapioca;* and being starch very nearly pure, is often prescribed by physicians as an aliment of easy digestion. A tolerably good imitation of it is made by heating, stirring, and drying potato starch in a similar way.

The expressed juice of the root of manioc contains in suspension a very fine fecula, which it deposits slowly upon the bottom of the vessels. When freed by decantation from the supernatant liquor, washed several times and dried, it forms a beautiful starch, which creaks on pressure with the fingers. It is called *cipipa*, in French Guyana; it is employed for many delicate articles of cookery, especially pastry, as also for hair powder, starching linen, &c.

Cassava flour, as imported, may be distinguished from arrow-root and other kinds of starch, by the appearance of its particles viewed in a microscope. They are spherical, all about 1-1000th of an inch in diameter, and associated in groups; those of potato starch are irregular ellipsoids, varying in size from 1-300th to 1-5000th of an inch; those of arrow-root have the same shape nearly, but vary in size from 1-500th to 1-800th of an inch; those of wheat are separate spheres, 1-1000th of an inch.

FUEL FOR STEAM ENGINES.

A LETTER from St. Petersburgh gives some particulars of a new fuel for steam-engines, discovered or manufactured by a M. Waschinakoff, which offers, it is said, great advantages over coal. We have, however, heard of so many of these wonderful discoveries in our own country, that we are a little sceptical; still it may be well to publish the facts as stated. The first experiment made, on a large scale, with this fuel, to which M. Waschinakoff has given the name of carboléin, was on board the English steamer Syrius, on its last voyage from Cronstadt to London; and the results are given as follows:—A consumption of 4½lb. (English weight) of carboléin per hour, for every horse-power of the engine, produced thirteen revolutions per minute, and yielded a speed of more than seven English miles per hour; whilst, on the same voyage, with 7lb. of English coal, of best quality, the wheel gave only twelve revolutions, and the vessel made no more than 6½ miles an hour. The flame of the new fuel, says Captain Waters, who commanded the Syrius, was so great, that they were constantly obliged to reduce it to one-third.—A cubic foot of the best Newcastle coal weighs nearly 55lb., whilst the same measure of carboléin weighs nearly 56lb.—2,480,000lb. of coal, the usual provision for steam vessels passing between England and the United States, occupy a space of 81.884 cubic feet; but 2,480,000lb. of carboléin yielding the same effect, take only 51.694 cubic feet; so that the latter combustible would effect a saving of room to the extent of 30.190 cubic feet, available for merchandize or passengers. The freight from England to North America, and vice versâ, being at the rate of 2*s.* 6*d.* per cubic foot, making 5*s.* both ways, the space economized, would produce, for the two passages, an excess of freight amounting, in value, to £7,547., deducting from this sum £643 for the greater price of the carboléin necessary for the two voyages over coal, and allowing, besides, £1,940 to the account of any deficiency which might occur in filling up the space saved, with goods or passengers, there would still be a clear gain, at the lowest calculation, of £5,000 by the use of the new fuel.—*Athenæum.*

MEMORANDA.

Action of Sulphur on Iron.—Colonel A. Evans has remarked that although sulphur has so strong an action on heated wrought iron, as immediately to form holes in it, yet it does not at all affect grey cast iron. A plate of wrought iron, 63 of an inch in thickness, heated to whiteness, and held against a roll of sulphur 6-10 of an inch in diameter, was, in fourteen seconds, pierced through with a perfectly cylindrical hole. Another bar, about two inches in thickness, was pierced by the same means in fifteen seconds. Good steel was pierced even more rapidly than the iron; but a piece of grey cast iron, well scaled and heated till nearly in fusion, was not at all affected by the application of sulphur to its surface, not even a mark being left. A crucible was made of this cast iron, and some iron and sulphur put into it; on applying heat, the iron and sulphur soon fused together, but the cast iron underwent no change.—*Ann. de Chim.*

Lead Ore in Glamorganshire.—The Cambrian observes—"It seems somewhat extraordinary, that in this speculating age, when such vast sums are sent to seek, and too often to sink, their fortunes in a far distant region, that our home treasures should be so disregarded, even our own county of Glamorgan. Lead ore, of the purest quality, which can even be scraped up by the sides of the road, in ditches, and abundantly a few feet beneath the surface of the soil, still continues to be dormant—science, capital, the gigantic power of the steam engine, all alike dormant. St. Hilary, Colvinstone, Langan, Penlline, and other parishes, abound in lead ore. Take up a handful of earth near any of the old pits, and it is full of lead ore. Twenty-five years ago, it was asserted by the oldest persons then living, that the working of the lead mines on the Penlline Court Estate was suspended (now from eighty to one hundred years ago) in consequence of the overwhelming pressure of water, years before the steam-engine, with its gigantic power, came into play, and that the main vein of ore at the time was thirty-seven inches in thickness. The ore was then carried above half a mile to be washed, and taken back again to the smelting-house, which adjoined the pits. The steam-engine would now admit of the ore being washed upon the spot."

Gold, Silver, and Copper Coin.—The following is the number of pieces of various sorts coined at the Mint from the 1st of January, 1837, to the 31st of December, 1840 : — Sovereigns, 4,395,373; half-sovereigns, 434,778 ; — crowns, *nil ;* — half-crowns, 567,072 ; — shillings, 9,741,600 ; — sixpences, 7,524,000 ;—fourpences, 6,070,680 ;—(the total number of fourpences issued being 10,325,320 ;) pence, 174,720 ; — halfpence, 1,075,200 ; — and farthings, 10,913,280.

Coal Dust as Manure.—Mr. W. H. B. Webster, Surgeon, R.N., of Ipswich, has paid some attention to this subject, the details of which may be found in the last part of the Transactions of the Society of Arts, London. The analogy between the constituent principles of coal to that of oily matter led Mr. W. to conceive that it might be advantageously employed as food for plants. The complete insolubility of coal dust seems to be the inseparable objection to its utility as a manure, and Mr. W. is inclined to believe, from a long continued series of observations, that the slender filamentous radicles of plants (in other words *spongeoles*) have a power in all respects equal, if not superior, to small electro-galvanic wires of low intensity, which, by slow continued action decompose most substances that are presented to them, and among others that of *coal dust.* Mr. W. also further states, that, whatever the vital principle may be, a lower grade cannot be assigned for it in the scale than that of electro-galvanic influence ; and we are not, says he, assuming too much for the vital action of the radicles, when we claim for them a power equal to that of small galvanic wires, which can and do effect a decomposition of coal dust. He then proceeds to demonstrate the fact, that coal dust is *not inimical* to vegetation, and this he accomplishes, by filling a series of garden-pots with fine coal dust, and planting and sowing a variety of plants therein, as potatoes, onions, &c. In all of them the vegetation was extremely vigorous and luxuriant. He also filled hyacinth glasses with coal dust, and put bulbs therein, supplying water as required ; and the result, when compared with those without the coal dust, was very marked and evident ; large, healthy, strong plants being produced, and admired by many.

Animalcules contained in Chara.—Thuret has observed in the interior of the anthers (globules) of *chara vulgaris* and *C. Hispida*, flexuose, transparent, chambered filaments of unequal length, in which are contained animalcules at first motionless, but after a time they move and struggle to release themselves from their prison. In this they do not always succeed, although their twisted position attests the efforts made for disengagement. They appeared like a spirally-rolled thread of three to five curves, with two appendages, bristles, or tentacula of excessive tenuity, which the animalcule incessantly agitates with great rapidity.—*Microscopic Journal.*

Air contained in Snow.—According to Dalton, the quantity of oxygen in the atmosphere diminishes in proportion to the distance from the surface of the earth. Gay-Lussac, however, did not find this to be the result of his experiments—for air which he obtained at a height of upwards of 20,000 feet, contained the same proportion of oxygen as that procured from the neighbourhood of Paris. M. Boussingault has found, in common with others, that air obtained from snow contains less oxygen than that of the atmosphere. But this holds good with regard to the snow of the Andes as to that of Paris. He admits, however, that this may not be the composition of the air as it exists in the snow ; because, in order to obtain this air, it is necessary to melt the snow ; the gas of the flask comes in contact with the water, little if at all impregnated with air resulting from the melting : and it is well known that in such circumstances oxygen dissolves more readily in water than the azote, and that the air with which water is saturated is richer in oxygen than that of the atmosphere. M. Dumas and M. Boussingault are at present examining the composition of atmospheric air.—*Athenæum.*

British Museum.—The number of visitors admitted to view the general collections from Christmas 1839 to Christmas 1840, amounts to 247,929, being 32,921 less than in the previous year. The number of visits made to the reading room, for the purpose of research or study, during the past year, amounts to 67,542, being 1,674 less than in the year before. The number of visits by artists and students to the galleries of sculpture, for the purposes of study, amounts to 6,354, being an increase of 1,513 to the previous year. The number of visits made to the print room, in 1840, amounted to 6,717. The total number of additions to the zoological department, by purchase or otherwise, 21,976 specimens.—*Report, House of Commons*, March 8, 1841.

Meteoric Paper.—The microscope has been ably employed by Ehrenberg to determine the composition of the meteoric paper of 1686, and which he states is a product of *confervæ* and *infusoria*, now existing on our globe. According to this author, the substance known by the name of meteoric paper, and which fell near Rauden, in Curland, in 1686, is formed of filaments of *conferva crispata*, thickly matted together, with remains of a nostoc, twenty-nine well-preserved species of infusoria, and the cases of *daphnia pulex.* Of the twenty-nine infusoria eight only have silicious *loricæ* ; the rest have soft coverings. In the meteoric paper of Schwarzenberg, Ehrenburg found *conferva capillaris*, *[illegible] punctalis*, and *oscillatoria limosa*, along with twenty distinct species of infusoria, &c. In a mass found in Sweden, *Œdogonium vesicatum* (Link) infusoria, and the *pollen* of some coniferæ were discovered.—*Microscopic Journal.*

Preservation of Meat.—At the last meeting of the Academy of Sciences, M. Gannal presented an important essay, which is likely to produce a considerable sensation amongst the public as well as in the scientific world. M. Gannal has been for many years occupied with the idea of preserving meat by injection. Thus, 4lb. weight of saline mixture injected into the carotid artery of an ox penetrates all the vessels, and prevents a putrid decomposition. M. Gannal presented two legs of mutton preserved two years since by this plan, and which were found to be perfectly sweet. M. Gannal employs for this purpose muriate of alum. This discovery is considered as valuable in preserving provisions for the navy.—*Times.*

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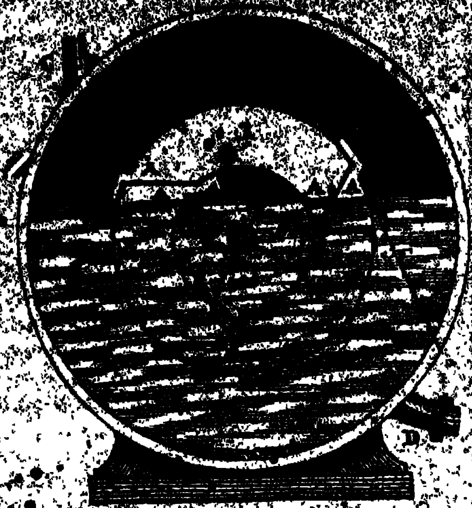

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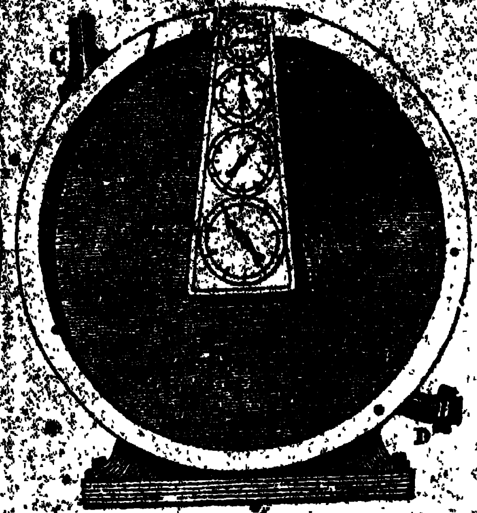

CLEGG'S GAS METER, GAS GOVERNOR, &c.

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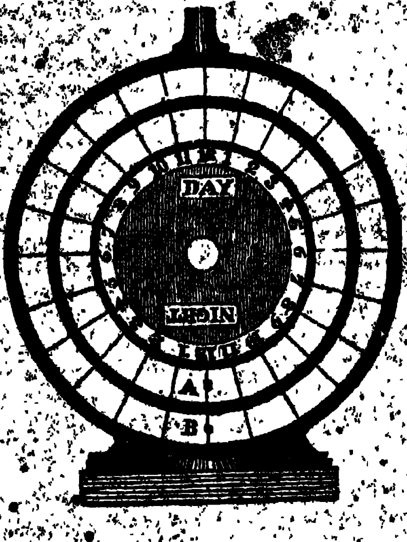

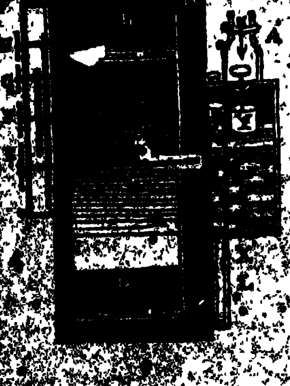

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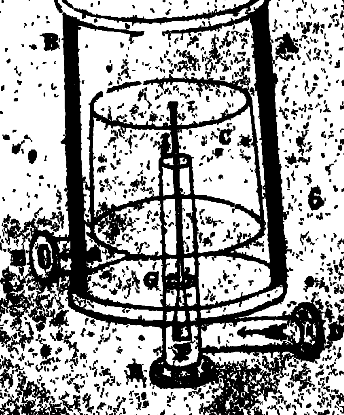

6

THE GAS METER.

For the invention of this machine we are indebted to the ingenuity and talents of Mr. Clegg, and undoubtedly of all the improvements with which the art of procuring light has been enriched, there is none which has been attended with results more beneficial to the interest both of the manufacturer and consumer of coal gas.

In this machine we see combined a standard or check on the conduct of the workmen, which enables the manufacturer of coal gas to assure himself of obtaining at all times the greatest possible produce from his establishment: a measure by which he can deal the gas out to his customers in whatever quantities they may require it, and an index which registers the exact quantities furnished, and thus serves as an infallible account of debtor and creditor between the seller and purchaser of gas.

This machine, therefore, performs at once all the duties of an overseer, meter, and book-keeper, and performs them all so much more effectually, that its operation is not dependant on matters so uncertain as the care or integrity of servants, but on unerring principles, which are fixed and incapable of any hidden misapplication.

Fig. 1, represents a perpendicular section of the gas meter. It consists of a hollow wheel or cylinder, made of thin iron plate, revolving upon an horizontal axis, in the manner of a grindstone; this wheel is inclosed in a cast iron air-tight case containing water.

The cylinder, or wheel, is composed of two circular channels, concentric to each other. The larger, or outer channel, is divided into three equal compartments, by partition plates, marked, as shown in the design. The compartments are provided with hydraulic ducts or valves, made at the upper part of every partition plate A, A, A, and by means of them a communication is formed between the larger concentric channel and the outer case in which the wheel revolves.

Similar valves are also placed at the foot of each partition plate, they are seen near the other letters A, A, A, and by this means, a communication is established, between each compartment or chamber of the larger concentric channel and the smaller interior circle of the wheel.

On inspecting the design, it will be seen that the valves are situated in opposite directions to each other, hence there can be no communication either between the inner smaller concentric channel, and the larger compartments of the wheel, nor between the latter compartment, and the exterior case, in which the wheel revolves, except through the valves A, A, A, &c., which form the communicating ducts. It will be seen also, that these valves are carried from one chamber of the machine into another, but in opposite directions; the entry into one chamber, being in the opposite direction to the hydraulic duct, placed in the other chamber.

From these particulars the action of the machine will be obvious.

Let us suppose that the outer case (which is marked in the sketch by a black tint,) in which the wheel revolves, be filled with water, to about an inch above the axis of the wheel, and that gas is conveyed into the interior small channel, by a pipe passing along the axis, so as to allow the wheel to turn freely round, and that the pipe is turned up at right angles in the inner chamber, and projects a little way above the surface of the water, as shown in the design. The gas then must enter into the interior chamber of the wheel above the surface of the water, and must press against the adjacent partition; it will therefore cause the wheel to turn round, and in consequence of this motion, the next partition plate will press the gas against the surface of the water, and cause it to pass through the hydraulic opening, in an equal quantity to that which is introduced into the exterior chamber.

This alternate filling, and discharging, of the contents of each chamber, will take place once during every revolution of the wheel, and hence the number of times each particular chamber has been filled, and emptied of gas, may be known.

In fact this machine performs the office of three revolving gas holders fixed on an horizontal axis, and moving in a cistern, which is the outer case of the machine. One gas holder, or one compartment of the machine, is always in the act of becoming filled with gas, another is emptying its contents into the outer case, from which it passes into the reservoir, where it is to be stored up, or to the lamps, where it is to be burned, and the third compartment, is stationary, or in an equilibrium. The wheel in any situation will therefore always have one of its receiving, and one of its discharging valves open, and consequently it will revolve.

Now to ascertain the quantity of gas discharged by one revolution of the wheel, we need only to know the capacity of the chambers, and add them together. Let us for example suppose, that each chamber contains 576 cubic inches, then one revolution of the wheel, discharges a cubic foot of gas. To register the total number, of revolutions which the wheel makes in a certain time, a train of wheel-work is connected with the axis of the meter; it consists of a pinion impelling a common train of wheel-work, composed of any number of wheels. The pinion on the axis of one wheel, acts into the circumference of the next wheel, and the circumference of the wheel being as ten to one, it is obvious whilst the meter makes 1,000,000 revolutions, if the series consists of six wheels, the last wheel of the series will only have made one revolution. Each axis of the wheels is provided with a finger and dial plate, divided into ten parts, therefore any number of revolutions may be read off at any time by inspection betwixt 1,000,000 and 1. (See Fig. 2.)

The velocity with which the meter acts, is of course in proportion to the quantity of gas passing through it. Thus suppose there is a burner or gas-lamp connected with the machine, of one foot capacity lighted, which consumes four cubic feet of gas in an hour, the gas meter performs four revolutions per hour, not exceeding the number which the machine is calculated to supply.

To render the construction of the gas meter more obvious, we have at Fig. 4, exhibited a transverse section of the machine; K is the outer case of the machine in which the wheel revolves. B, B, the outer or larger concentric chamber. M the inner or smaller concentric chamber. D the index on the axis, which passes through a stuffing box in front of the machine. A is the inlet pipe for the gas to enter into the machine. The gas passes through the pipe C, and from thence into the curved pipe D, into the interior chamber M, of the meter. The pipe H, is surrounded by a second pipe L, which has a small aperture at X, the office of which is to act as a syphon, in order to preserve the proper level of the water, which is poured into the machine through the funnel at the back of the entrance pipe A. Y is a float, which stops the performance of the meter altogether, if a fraudulent attempt should be made to stop the registering of the meter, by drawing off the water with which it is charged. In Fig. 1, C is the inlet pipe; D the outlet pipe of the gas.

The Gas Governor.—Fig. 6, is an instrument invented by Mr. Clegg, for regulating the inequalities arising from the irregular pressure of the gas-holders, as well as that from the putting out of the lights at different periods of the night. This contrivance consists of a small gasometer of sufficient weight for producing the required pressure; the interior of it is in direct communication with the pipe through which the gas passes. This gasometer is connected with a regulating valve, so that when the pressure at any time increases, the gasometer rises and *contracts* the opening; and, on the contrary, if the pressure diminishes, the gasometer falls and *increases* the opening. In every case, the aperture is always in unison with the demand, preserving the flame at one uniform height. Its purposes are more effectually accomplished by placing one, on a small scale, in each house; but one on a large scale, placed at the main outlet at the gas works, will equalize the general pressure, and seems to be absolutely necessary where governors are not individually used. This is a self-acting machine, and requires no alteration when once adjusted. The following description will probably render it intelligible:—

Fig. 6, is a section of the governor, and A B exhibit the outer case; this is made of sheet-iron or copper, with the top and bottom closed, and both the inside and outside are also japanned. C shows the form of the small gasometer. D the pipe by which the gas enters; and E the pipe by which it passes out. The conical valve attached to the bottom of the upright spindle I, rises and falls, so as to contract or enlarge the aperture G, as the gasometer ascends or descends by the entrance or passing out of the gas; and H is a short hollow cylinder or cup, in which the outer case is fixed at the centre of its base.

Mr. Crosley has made some improvements in the construction of the governor for regulating the supply at the main outlet of the works, so that, by its own action, the pressure is increased or diminished with the quantity supplied. One of the modes he employs is in the construction of the small gasometer. Some years ago, by making an experimental gasometer on a small scale, and requiring uniform pressure for comparing the intensities of light, instead of using a compensation chain, which it is not easy to make free from friction, he found that he could effect the same, in a more simple way, by making the gasometer less in diameter at the top than at the bottom. Hence, by increasing this difference, the gasometer may be made to vary its pressure to any required degree. He also effects the same purpose by employing a gasometer of the common construction, making the necessary compensation by means of a cycloidal wheel, over which the balance-weight is suspended. This wheel is formed with moveable pegs for varying the curve, and adapting it at pleasure to any required variations.

By certain modifications of the governor, Mr. Crosley has already rendered it capable of regulating the discharge of gas from a portable gas vessel, so that, without any adjustment of the valve, the flame is preserved uniform from the beginning, through all the variations of pressure, from thirty atmospheres down to that of common gasometers.

The Gas Register is a simple and ingenious instrument for indicating and registering the impurities of the gas, and which, at the same time, denotes the periods when they occur.

The arrangement of this apparatus consists of a circular card placed upon an axis, which communicates with a time-piece. Upon this card three circles are described which are divided into 24 divisions by lines drawn from the centre, corresponding with the hours of day and night. The two largest circles, (A B, Fig. 3,) which are of equal breadth, occupy the marginal space at the outer extremity of the card; these are coated with the usual solutions or tests for sulphuretted hydrogen and ammonia, and a very small jet of gas, from an orifice adapted to each of the circles, is made to play constantly over them. The inner circle being divided into spaces that are marked from 1 to 12 for day, and 1 to 12 for night, hence, as the axis of the time-piece performs its revolution with the card attached to it, the impurities, and the time when they happen, become exactly registered; and by changing these cards daily a perpetual register is obtained. The principle on which it acts renders the managing of it readily attainable; and its utility is obvious.

Specific Gravity Apparatus.—Another valuable addition to the apparatus relating to gas, for which the public is indebted to Mr. Crosley, is a very simple and efficient contrivance for ascertaining the *specific gravity* of carburetted hydrogen gas, which he has accompanied with an appropriate table for rendering the calculation easy and concise, at different temperatures and barometrical pressures. Fig. 5, is a figure of the instrument, and the description annexed is copied from Mr. Crosley's.

The specific gravity of carburetted hydrogen gas being one of the leading tests of its illuminating power, the following easy method of ascertaining it is submitted for the use of those who are engaged in the management of gas-light establishments:—

"The figure represents the form of a flask, with an opening and cap at each end, which may be completely discharged of the air, and filled with gas, by placing one of its ends upon a pipe or cock, of the same size, and passing a current of gas through it in the following manner:—A projection is placed on each side of the flask, by which it is intended to be held in the hand, so that the temperature of the gas or air within may not be increased.

Previously to the flask being filled with the gas intended to be weighed, let it be freed from foul air, or gas, by taking off the caps from each end, and passing a current of fresh air through it, until the air within is the same as without; this may be easily effected by moving it quickly and repeatedly to and fro, endways, in the air; the caps may then be put on, and the flask accurately balanced; this being done, take off the caps, and pass a current of gas through it during about ten seconds of time: then put on the cap at the upper end, and, at the instant of disengaging the bottom end of the flask from the pipe or cock, put on its cap, and immediately weigh it again, when the diminution or counter-weight, required for restoring the balance, will give the specific gravity of the gas.

TO OBTAIN PURE PLATINUM.

Platinum is found, in the metallic state, in small grains, in South America, confined to alluvial strata, chiefly in Brazil and Peru. It has also been found in the province of Antioquia, in North

America; and in considerable quantities in the Uralian mountains of Siberia. The grains, besides platinum, contain generally gold, iron, lead, palladium, rhodium, iridium, and osmium, and often oxide of titanium and chromate of iron. Rounded masses of the metal, however, occasionally occur among them, and are met with in mineral collections; these are rarely larger than a small marble; though some have been found of the size of a pigeon's egg and upwards.

The pure metal may be obtained by dissolving crude platinum in nitro-muriatic acid, and precipitating by a solution of muriate of ammonia. The first precipitate is heated, re-dissolved in nitro-muriatic acid, and again precipitated as before. The second precipitate is heated white-hot, and pure platinum remains. It is a white metal, extremely difficult of fusion, and unaltered by the joint action of heat and air. It varies in density from 21 to 21.5, according to the degree of mechanical compression which it has sustained; it is extremely ductile, but cannot be beaten out into such thin leaves as gold and silver.

The following details respecting the mode of purifying platinum, and rendering it malleable, are taken from Dr. Wollaston's latest paper upon this subject, published in the *Philosophical Transactions* for 1829:—

"The usual method of giving chemical purity to this metal, by solution in aqua regia and precipitation with sal-ammoniac, are known to every chemist; but I doubt whether sufficient care is usually taken to avoid dissolving the iridium contained in the ore, by due dilution of the solvent. In an account which I gave in the *Philosophical Transactions* for 1804, of a new metal, rhodium, contained in crude platina, I have mentioned this precaution, but omitted to state to what degree the acids should be diluted. I now, therefore, recommend, that to every measure of the strongest muriatic acid employed, there be added an equal measure of water; and, that the nitric acid used be what is called "single aquafortis;" as well for the sake of obtaining a purer result, as of economy in the purchase of nitric acid. With regard to the proportions in which the acids are to be used, I may say, in round numbers, that muriatic acid, equivalent to 150 marble, together with nitric acid, equivalent to 40 marble, will take 100 of crude platinum; but in order to avoid waste, and render the solution purer, there should be in the menstruum a redundance of 20 per cent. at least of the ore. The acids should be allowed to digest three or four days, with a heat gradually raised. The solution, being then poured off, should stand until a quantity of fine pulverulent ore of iridium, suspended in the liquid, has subsided; and should then be mixed with 41 parts of sal-ammoniac, dissolved in about five times their weight of water. The first precipitate, which will thus be obtained, will weigh about 165 parts, and will yield about 66 parts of pure platinum. As the mother-liquor will still contain about 11 parts of platinum, these, with some of the other metals yet held in solution, are to be recovered, by precipitation from the liquor with clean bars of iron, and the precipitate is to be re-dissolved in a proportionate quantity of aqua regia, similar in its composition to that above directed: but in this case, before adding sal-ammoniac, about one part by measure of strong muriatic acid should be mixed with 32 parts by measure of the nitro-muriatic solution, to prevent any precipitation of palladium or lead along with the ammonio-muriate of platinum. The yellow precipitate must be well washed, in order to free it from the various impurities which are known to be contained in the complicated ore in question; and must ultimately be well pressed, in order to remove the last remnant of the washings. It is next to be heated, with the utmost caution, in a black-lead pot, with so low a heat as just to expel the whole of the sal-ammoniac, and to occasion the particles of platinum to cohere as little as possible; for on this depends the ultimate ductility of the product.

"The grey product of the platinum, when turned out of the crucible, if prepared with due caution, will be found lightly coherent, and must then be rubbed between the hands of the operator, in order to procure, by the gentlest means, as much as can possibly be so obtained, of metallic powder, so fine as to pass through a fine lawn sieve. The coarser parts are then to be ground in a wooden bowl with a wooden pestle, but on no account with any harder material, capable of burnishing the particles of platinum; since every degree of burnishing will prevent the particles from cohering in the further stages of the process. Since the whole will require to be well washed in clean water, the operator, in the later stages of grinding, will find his work facilitated by the addition of water, in order to remove the finer portions, as soon as they are sufficiently reduced to be suspended in it.

"Those who would view this subject scientifically, should here consider, that as platinum cannot be fused by the utmost heat of our furnaces, and consequently cannot be freed, like other metals, from its impurities, during igneous fusion, by fluxes, nor be rendered homogeneous by liquefaction, the mechanical diffusion through water should here be made to answer, as far as may be, the purposes of melting; in allowing earthy matters to come to the surface by their superior lightness, and in making the solvent powers of water effect, as far as possible, the purifying powers of borax and other fluxes in removing soluble oxides.

"By repeated washing, shaking, and decanting, the finer parts of the grey powder of platinum may be obtained as pure as other metals are rendered by the various processes of ordinary metallurgy; and, if now poured over, and allowed to subside in a clean basin, a uniform mud or pulp will be obtained, ready for the further process of casting."

DIMINUTION OF TEMPERATURE ON COASTS, SANDBANKS, &c.

IN the third number of the Journal of Science and the Arts, an extract of a letter from Dr. Davy, has been published; containing some observations on the temperature of the ocean and atmosphere, in the equatorial regions of the globe. Amongst other philosophical remarks, those by which he confirms the conclusion of Mr. Jonathan Williams, and other observers, that the temperature of the sea always falls in shoal water, and that the thermometer may be made a useful instrument in navigation, appear to be very important.

Mr. Williams attributes the effect upon the thermometer, on the approach of land, to the cooling power of the land; but this reason will not apply to the effect of shoals in the ocean, or to the tropical climates. M. de Humbold, in his Personal Narrative, seems to consider it as resulting from cold currents below the surface; but in his work he does not enter into any minute details; nor did he pursue it any further, than in mentioning this general opinion. Dr. Davy has merely noticed the fact, as a general law; but has not speculated upon the cause of it.

The solar rays produce very little heat, in passing through the air; but during their transmission through a body so imperfectly transparent as water, there can be no doubt that the same cause which occasions a loss of light, must communicate an effect of heat, and consequently, the greatest heat must be produced at the surface of the sea, and it must gradually diminish, as the rays penetrate deeper.

The heat of the surface of the ocean must, at a great distance from land, depend upon the absorption of the solar rays, the cooling of this surface upon its radiating powers, and upon evaporation. But water is an imperfect conductor of heat; and by cooling, as far as 38° or 40° of Fahrenheit, its density is increased: when cooling agencies act upon an unfathomable ocean, the strata of water cooled sink out of the reach of the surface, and very little influence the temperature of this surface; but when cooling agencies act upon a shallow part of the ocean, the cooled strata accumulate and approach nearer the surface, and cause the temperature of the ocean, at its surface even, to be nearer the mean temperature of day and night.

In very shallow water, close to the shore, the bottom will be heated; and during the day the temperature, close to the shore, will be higher than that of the ocean; but in the night, as the land cools faster than the sea by radiation, the air, having its temperature lowered by contact with the cooled land, will flow down upon the sea, and thus will destroy the effect of the hot water flowing from the extreme shallows, and at a certain moderate distance will produce such a diminution of temperature, as will more than compensate for the heat produced by contact with hot land. Hot-air and water, within limits above 52° always rise; water cooled below 40° also rises; therefore, by whatever cause cool air or water are kept near the surface of the ocean, that cause will diminish the general temperature of that surface.

It has been supposed by M. Perron, and other inquirers, that ice may exist at the bottom of the ocean; but simple physical reasons show that this is impossible, unless the temperature of the surface of the ocean is below 40°, for water at 40°, is heavier than at the freezing point. Ice, as Count Rumford has shown, always forms at the surface: and ice at the bottom of any part of the ocean, must begin to thaw, when the temperature of the surface is above 40°: for hot currents then descend, and cold ones rise.

The same cause must always operate, when the heat of the surface of the ocean is above 52°; and under these circumstances, whether in the equatorial, polar, or tropical climates, land or shallows must always lower the temperature of the ocean: but in very high latitudes, if the heat of the surface should approach to 40° only, the thermometer will no longer be a guide of land to the navigator, for water is heavier at 47°, than at the freezing point 32°; but such an occurrence can only happen in icy seas.

HOW TO STUDY CHEMISTRY CHEAPLY.

BY JAMES HERBERT COOKE.

It is a common opinion, that in order to study any science practically, a person must necessarily incur a great expense; that this is, to a certain extent, correct, cannot be denied, as the higher branches of every science frequently require instruments of a delicacy and exactness of construction far beyond the skill of the experimentalist himself, and which cannot be procured without considerable expense; at the same time, however, a person may, with but a trifling expenditure, make himself acquainted with all the chief facts of a science, and even pursue it to a considerable extent, with the aid of such apparatus as he may contrive, by a little ingenuity, or procure at but little cost: this is peculiarly the case with chemistry, which may be studied with little expense, to a greater extent than perhaps any other science.

The advantages to be derived from a thorough knowledge of chemistry, (which can only be acquired from experiment,) are very great, as well as every other branch of science as well as art, is more or less dependant on it, and many of them owe some of their chief facts to the chemical knowledge possessed by the discoverers of them; nevertheless, chemistry is far less studied than its importance deserves, the generality of people either knowing nothing at all about it, or, at best, resting in a mere theoretical knowledge of some of its principal facts, under an impression that it requires too large an outlay, to be followed by any but those whose profession requires it. This idea is, perhaps, strengthened by attending chemical lectures, where, as the lecturer generally makes a point of exhibiting as much apparatus as possible on his table, the uninitiated are apt to suppose that all this display of brass and mahogany is essentially necessary to the student—than which, nothing can be more erroneous. Another, and perhaps a chief cause why chemistry is not more studied, is the extravagant price charged by the philosophical instrument makers, their charges acting, in many cases, as a complete prohibition of the use of their instruments, to persons of but limited means.

The object of these papers is to show to the young how they may study chemistry with most profit to their purses, as well as to themselves. I do not profess to advance anything new, but simply to explain the construction and use of such articles of apparatus as will supply the place of the more expensive ones usually figured and described in chemical works; many of them are the invention of persons whose names stand high in the annals of science, and as all of them have been used, for a long time, and with success, by myself, I can conscientiously recommend them. The use of cheap apparatus has at all times been supported by the example of the first philosophers. Dr. Priestley used, for several years, no other pneumatic-trough than a small washing-tub, and made some of his most brilliant discoveries with it, and it is well known how economically Franklin proceeded. Of late years, much has been done with the *professed* intention of benefiting the cause of science, by the introduction of some very pretty, French polished, brass-bound, mahogany chests of apparatus, tests, &c., under the name of "portable laboratories," which, however, are, apparently, more for ornament than use: if for use, it is decidedly the most expensive plan of proceeding that the student can adopt, as all the apparatus they contain may be bought for less than one-fourth the price charged for them, and the materials are less in quantity than would be required even for specimens; they are indeed anything but what would be really useful, especially to a person who wishes to study with as little expense as possible.

I shall also give a course of instructive experiments illustrative of the usual routine of manipulation, so as to give the young student a fair start, and enable him afterwards to proceed in acquiring a knowledge of this science, one of the most useful and important of the whole circle, thereby opening to him not only an inexhaustible source of instructive amusement, but what will prove of infinite service to him in the every-day transactions of business, and which, in every path in life, gives its students a manifest superiority over those who are unacquainted with it.

The principal articles required by the student are the following, viz.:—1. a spirit lamp; 2. a lamp stand; 3. apparatus for making gases; 2. pneumatic-trough; 5. gas jars; 6. evaporating dishes; 7. test glasses; 8. a glass funnel; 9. blowpipe

1. *A spirit lamp.*—This is a small lamp intended to burn spirits of wine, provided with a wick-holder, and a cap to prevent loss of fuel by evaporation; it is used to heat flasks, evaporating dishes, &c., and gives a considerable heat, without smoke. A very good and cheap one may be made in the following manner: take a short glass bottle that will hold two ounces, or more, and will stand steadily; break off carefully the lip of the neck, with pincers, and smooth the edges with a file, or on a sandstone; then take a good sound cork, or small bung, cut a hole through the middle of it, and fit it tightly on the neck of the bottle, to which it may be cemented with glue, and cut it off level with the top of the neck. The *cap* may be made either of tin plate or of the bottom of a phial, cut off with a red-hot wire, and must fit closely over the cork. The wick-holder is of tin plate, about 2 inches long, and ⅛ of an inch wide, with a rim or ledge ¼ of an inch from its upper end, which rests on the neck of the lamp, and must be wide enough to cover the top of the cork, and protect it from the flame. A larger or smaller flame is produced by pulling up or pushing down the wick in the wick-holder. Wicks may be had at the oilman's, in balls, about 6d. each; the usual fuel is spirits of wine, but naphtha will do equally well, and is only two-thirds of the price, but has the disadvantage of a strong and disagreeable smell. This lamp will be found equal to any that is made, and will not cost more than 6d.

A useful appendage to the spirit lamp, when a flask or other large vessel is to be heated, is a tin cylinder wide enough to go over the lamp and about five inches high, having several arched openings cut in the bottom to admit air; when the lamp is placed within it, it keeps the flame steady, protects it from draught, and at the same time causes a current of hot air to ascend and circulate round the bottom and up the sides of the vessel, thereby heating it much more effectually than could be accomplished by the lamp itself.

2. *A lamp-stand* is used to support vessels over the spirit lamp. The following will answer the purpose very well, and is easily constructed: take three pieces of stout iron or brass wire, each 18 inches long, and bend them into the figure of a square staple; then bind them firmly together at the angles and near the ends with thin copper wire, so that the sides of each may form a triangle, each side being 4 inches long, standing on three legs, each 7 inches long; when the vessel employed is too small to stand on the triangle, smaller triangles, made by twisting together the ends of three short pieces of wire, may be placed on the large one; in order to apply a greater or less degree of heat, the lamp should be adjusted at different heights beneath the vessel by means of pieces of wood of various thicknesses, of which several should be provided.

3. *Apparatus for generating gases.*—Gases that require heat for their extrication, may be made in Florence flasks, which can be obtained at an oilman's for 1*d.* each; they must be well cleaned with pearlash and hot water previous to being used: a glass tube passed through a cork, is fitted to the neck, to conduct the gas to the jars intended for its reception; the tube should be about 20 inches long and ⅓ of an inch wide, and should be bent at an angle, about three inches from one end, by means of the spirit lamp and blow pipe, as will be hereafter explained.

For making hydrogen, carbonic acid, and other gases, where heat is not required, any bottle with a bent glass tube passed through the cork, similar to the flask, will answer the purpose; it should not hold less than four ounces.

4. *A pneumatic trough* is a large vessel filled with water, for collecting gases, and provided with a perforated shelf to support the jars while filling; a wash-hand basin will answer the student's purpose very well: for a shelf, take a 2-oz. gallipot, and bore a hole ⅓ of an inch in diameter through the bottom with a large nail or any such tool; then, with pincers, make an arched opening in the edge, about ½ an inch wide and ¾ of an inch high; these apertures may be finished off with a file; this being inverted on the bottom of the basin, which is filled with water, the apparatus is ready for use.

5. *Gas jars.*—For collecting and experimenting with gases, 4 oz. phials may be used; a bottle that will hold half a pint or more, the bottom cut off with a red-hot wire, is useful for many experiments; the phials will cost about 3*d.* each, and should be chosen as wide in the neck as possible.

6. *Evaporating dishes.*—Vessels for evaporating are generally made of Wedgewood ware, but as this is expensive, and not absolutely necessary for mere experiments on crystallization, &c., the student may use common gallipots, which he will find as useful as vessels of ten times the price; they may be had of various sizes at about 1s. per dozen.

7. *Test glasses, &c.*—Vessels for testing, precipitations, &c., may be replaced by wine glasses and tumblers: when a precipitate is to be collected, ale or champagne glasses are preferable on account of their depth; glass rods for stirring solutions may be had in most towns, at from 1*d.* to 3*d.* each, or where they cannot be procured, narrow slips of window-glass may be used.

8. *A glass funnel*, for filtering, &c.; one 2½ inches diameter will cost 6*d.*; filtering paper is sold at the druggists at 2*d.* per sheet.

9. *A blow pipe.*—This is a small instrument used in conjunction with the spirit lamp for exciting an intense heat on a small scale; a common tapering tube will answer the student's purpose.

This list includes nearly every thing required by the student; a few miscellaneous articles, such as deflagrating spoons, &c., will be described when we come to the experiments in which they are used.

(To be continued.)

ON THE EXPANSION OF ARCHES.

The expansion of solids, which has excited the attention of mathematicians since the investigations of La Hire, in 1688, on a rod of iron, is of particular importance in the construction of bridges, the security of which may be affected by the dilatation and contraction consequent on changes of temperature. Periodical motions, referable only to changes of temperature, were observed by Vicat, in a stone bridge, built over the Dordogne, at Souillac, and have frequently been noticed in structures of all kinds. The different expansibilities of stone and iron have been considered an objection to the use of cast iron pillars in connection with stone, to support the fronts of buildings; but the experiments of Mr. Adie, of Edinburgh, led him to the conclusion that no danger is to be apprehended from a change of temperature affecting cast iron and sandstone in any great degree, as their expansion, so far as regards buildings, may be considered the same. Arguments from this source were employed against the arches of Southwark-bridge, and the experiments set forth in this communication were undertaken with a view of ascertaining the effect of temperature on these arches. Three sets of experiments were made, the first in January, 1818, when the main ribs and diagonal braces rested on their centres, and before any of the spandrils and road plates had been put upon them; the second in August and September of the same year. The rise was measured by the insertion of small wedges, by which the rise was ascertained to about one-fortieth part of an inch. The most extensive set of experiments was made on the eastern arch. Great care was taken in observing the thermometers, of which there were three; one in the open air, another among the ribs, and the third inserted in the iron of the rib. The result of nine experiments gave, as a mean, a rise of one-fortieth part of an inch for 1° F. The effects of changes of temperature were also observed in the stone bridge over the Thames, at Staines. After the arches had obtained their full settlement, openings were observed in the joints of the parapets immediately over the springing of the arches, and a distortion, or sinking, of the upper curve of the parapets. A wedge was inserted into some of these openings, and the lowest point of its descent, in the month of January, marked. The same wedges were carefully inserted every week until May, when they would no longer enter, and the joints became firmly closed. At this period, however, the joints immediately over the crowns of the arches, which had, during the winter, been quite close, were open. From these facts it follows, as a necessary consequence, that in winter the arch contracting descended, and the spandril joints opened; and in summer the arch expanding rose, and closed these joints, and opened those at the crowns. Thus, the joints of the parapets, which were made of single slabs of granite for the whole height, became good indicators of the change of temperature. It had also been observed in the Waterloo and other bridges, that, joints made good in the winter with Roman cement, were found crushed in summer.

NEW TEST LIQUOR FOR ACIDS AND ALKALIES.

The thanks of the Society of Arts have been voted to Mr. J. Marsh, of the Royal Arsenal, Woolwich, for his communication of the following new test liquor for acids and alkalies.

The infusion of the common red cabbage has been long in use in the chemical laboratory, as a test to distinguish acid from alkaline bodies when in solution; and, although possessed of great delicacy in this respect, is still subject to an objection, on account of its becoming so exceedingly offensive in its smell, after having been prepared a few months.

In order to obviate this objection, Mr. Marsh undertook some experiments, about two years ago, on the coloring matter of the dark red hollyhock, the purple radish, and the dark red beet-root: but, during his experiments, he found many objections to all. The beautiful blue color of the dark red hollyhock, obtained by alcohol, is, however, worthy of notice; but Mr. Marsh's attention was forcibly drawn to the beautifully colored infusion obtained from the dark varieties of the dahlia, such as the Conqueror of Sussex, Sir Edward Codrington, Sir Edward Sugden, Alman's Splendissima, Parson's Rival, Brown's Ion, Holmes's Rival, Sussex Lima, Metropolitan Perfection, Pasha of Egypt, Robert le Diable, and Sambo—these being the varieties mostly employed.

This infusion is easily obtained as follows:—Into an infusion pot or any common earthen vessel, let as many of the petals of the above-named dahlias be lightly pressed, and then boiling hot distilled or good rain-water, sufficient to cover the petals about an inch, be introduced. The best method of keeping them down is by means of a piece of plate-glass, or the foot of a broken tumbler, or even a piece of common porcelain will do very well. The whole may be kept on the hob of a common fire-place, simmering for two or three hours, covered over with a piece of common paper, to keep out any dirt which otherwise might fall in. The liquor is then to be poured off the petals, which will be found almost colorless. To every pint of the infusion, add half an ounce of sulphuric acid, keeping the whole slowly stirred with a slip of glass. When quite cold, add to every pint of the mixture two grains of corrosive sublimate dissolved in a portion of the liquor: filter the whole through a piece of coarse cloth, and bottle it up; and it is immediately fit for use.

When wanted for use, the liquor is to be carefully neutralized by ammonia, which gives it a kind of olive color, and in this state it may be used liquid; or bibulous paper may be dipped in it, and then dried. Either the liquor or the paper will become green with alkalies, and red with acids.

Being desirous of turning to account some of the qualities of this class of flowers now so much cultivated and so generally admired, and also rendering them useful as well as ornamental, Mr. Marsh has made several attempts to fix it as a dye-stuff on cloths, &c.; but has not yet succeeded in his attempts to his own satisfaction.

This test liquor has been approved of and adopted at the Royal Military Academy and Royal Institution.—*Transactions of the Society of Arts*

MISCELLANEOUS EXPERIMENTS.

Watch Glasses.—The art of making watch-glasses depends upon the employment of caloric, as a power which expands glass unequally. A glass globe is blown of sufficient size to permit five glasses being cut from it. When the globe is cold, a red-hot tobacco-pipe, or iron-wire, is run round the model of the watch-glass drawn upon it; the crack follows the point of the heated wire or pipe, until the circle is described, and the watch-glass drops out of its place. The other four are done in the same way. This contrivance is admirable, considering that it arose from what is generally supposed to be a bad property of glass, viz. fracture by heat too suddenly applied.

Substitute for a Copying Machine.—Write with common writing ink in which lump sugar has been dissolved, in the proportion of four scruples, or a drachm and a half of sugar to one ounce of ink. Moisten copying paper, (a paper which is sold at the stationer's for 1s. 10*d.* per quire, for the use of copying machines,) by passing a wet soft brush over it, then press it gently between soft cap paper, so as to smoothen it, and absorb the superabundant moisture. Put the paper so moistened upon the writing, and both between cap or other smooth soft paper, placing the whole on the carpet or hearth-rug, one end of which is to be folded over. By standing and treading upon this, an impression will be taken, equal, if not superior, to what would have been taken by a copying machine.

Tracing Desk. Let a frame be made sufficiently large for a square of crown glass to rest upon it, supported by a ledge at the bottom part; where, by two hinges, it may be fastened to a drawer of the same dimensions, which may be divided to serve for paper, pencils, &c. To the top of the frame, fix two stays, by which the frame may be raised or depressed, as occasion may require The frame is to be used thus:- lay the subject you intend to copy on the glass, and fasten a sheet of fine white paper upon it, with some wafers or paste. If you work in the day-time, place the back, after you have raised the frame to a proper height, against the window; but if by night, put a lamp behind it, and you will see every line, which you may copy accurately, and finish as you think proper. If it be a solid piece you intend to copy, then place it behind the desk, and having fastened your paper to the frame, put the lamp so as to produce a strong shade on the object you have before you to draw, and you will plainly see to trace the lines with a black lead pencil: after which, fill up the shades in the manner it appears without the desk.

Optical Experiments.—Affix to a dark wall a round piece of paper, an inch or two in diameter; and a little lower, at the distance of two feet on each side, make two marks; then place yourself directly opposite to the paper, and hold the end of your finger before your face in such a manner, that when the right eye is open, it shall conceal the mark on the left, and when the left eye is open, the mark on the right: if you then look with both eyes to the end of your finger, the paper, which is not at all concealed by it from either of your eyes, will nevertheless disappear.

Fix, at the height of the eye, on a dark ground, a small round piece of white paper, and a little lower, at the distance of two feet to the right, fix up another, of about three inches in diameter; then place yourself opposite to the first piece of paper, and, having shut the left eye, retire backwards, keeping your eye still fixed on the first object; when you are at the distance of nine or ten feet, the second will entirely disappear from your sight.

A Simple Barometer.—Take a common phial bottle, and cut off the rim and part of the neck. This may be done by a piece of string, or rather whipcord, twisted round it, and pulled strongly in a sawing position by two persons; one of whom holds the bottle firmly in his left hand. Heated in a few minutes by the friction of the string, and then dipped suddenly into cold water, the bottle will be decapitated more easily than by any other means. Let the phial be now nearly filled with common pump-water, and, applying the finger to its mouth, turn it quickly upside down: on removing the finger, it will be found that only a few drops will escape. Without cork or stopper of any kind, the water will be retained within the bottle by the pressure of the external air; the weight of air without the phial being so much greater than that of the small quantity within it. Now let a bit of tape be tied round the middle of the bottle, to which the two ends of a string may be attached, so as to form a loop to hang on a nail; let it be thus suspended, in a perpendicular manner, with the mouth downwards, and this is the barometer, When the weather is fair, and inclined to be so, the water will be level with the section of the neck, or rather elevated above it, and forming a concave surface. When disposed to be wet, a drop will appear at the mouth, which will enlarge till it falls, and then another drop, while the humidity of the atmosphere continues.

How to prepare Parchment for Painting.—Take about a yard and a half of list, and roll it up very tight in a circular form; then take some finely powdered white pumice-stone, put the list in it, and rub it over the parchment. This plan, which is simple and very common, answers the best of any. If you wish it to take water colors without sinking, choose that which is not spongy and soft, and use alum-water with the colors when you mix them for use.

Easy Method of taking Impressions from Medals, Coins, &c.—Boil a quantity of isinglass in rum, brandy, or other spirit, till it is in a sufficiently liquid state to pour upon the metal, &c. Any color may be mixed with this composition; but it must be poured in a liquid state to the mixture, it is best to mix the color with the spirit.

Artificial Rain and Hail.—Make a hollow cylinder of wood; let it be very thin at the sides, about eight or ten inches wide, and two or three feet in diameter. Divide its inside into five equal parts by boards of five or six inches wide, and let there be between them and the wooden circle, a space of about one sixth of an inch. You are to place these boards obliquely. In this cylinder put four or five pounds of shot that will easily pass through the opening. When turned upside down, the noise of the shot going through the various partitions will resemble rain; and if you put large shot, it will produce the sound of hail.

To make a Ring suspend by a Thread, after the Thread has been burned.—Soak a piece of thread in common salt and water. Tie it to a ring not larger than a wedding ring. When you apply the flame of a candle to it, it will burn to ashes, but yet sustain the ring.

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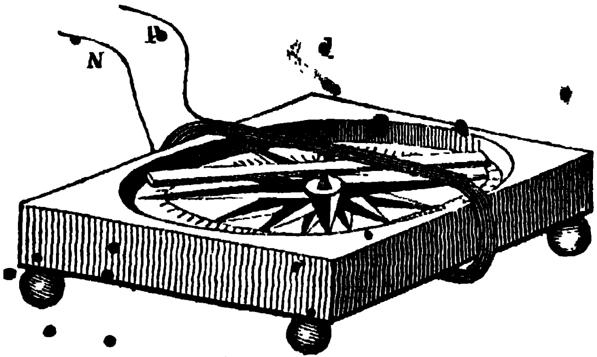

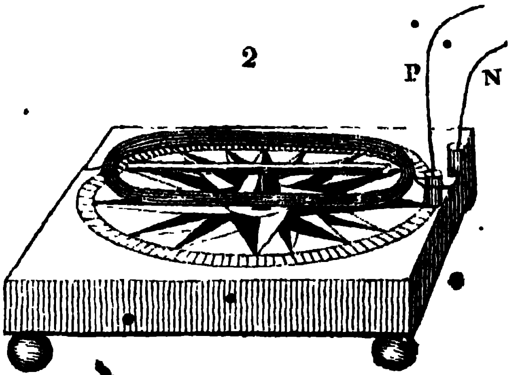

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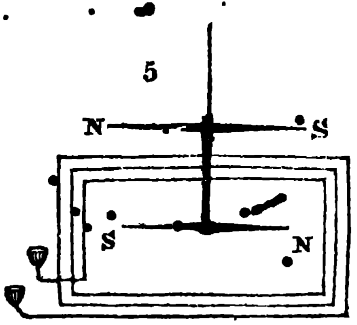

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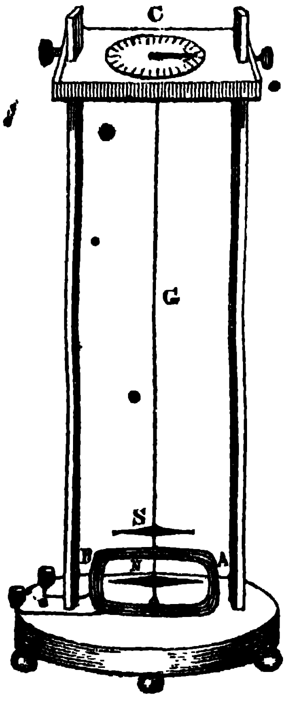

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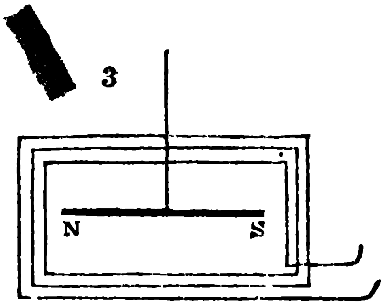

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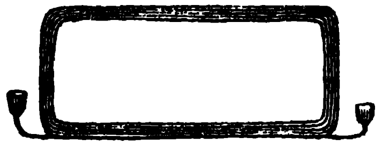

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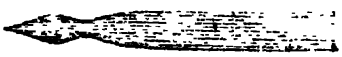


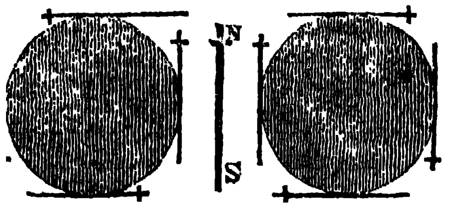
THE GALVANOMETER.

A GALVANOMETER, as its name implies, is an instrument for measuring a galvanic force emanating from a conducting wire, which is the transmitting medium of an electric current flowing from the positive to the negative pole of a galvanic or voltaic battery; or it is a measurer of the force of any electric current, from whatever source of excitation it may proceed.

Its action depends entirely upon the principles of electro-magnetism, which were discovered in 1819, by Professor Œrsted, of Copenhagen; and its indications are deflections of a magnetic needle, situated within the sphere of the electro-dynamic action.

The first instrument which bore any of the appearances of the galvanometers in present use was the *multiplier* of Professor Schweigger; which was simply a compass box with a copper wire coiled several times round it, whose convolutions were parallel to the meridian line of the card. This instrument being adjusted to the magnetic meridian, its needle would rest in the plane of the coil, by the force of terrestrial magnetism. If, however, the ends of the coil wire were to be connected, one with the positive, and the other with the negative poles of a voltaic battery, the coil would become a channel for an electric current; and the electro-magnetic force of this current operating on the compass-needle would deflect it out of its natural direction; and after a few oscillations it would take a new stationary position. This new position of the needle would not be at right angles to the plane of the coil, because of its still being under the influence of terrestrial magnetism, as well as under the influence of the electro-magnetic force; but it would form an angle with the meridian line of the compass-card, the extent of which would depend upon the extent of the latter force; or, if you please, upon the intensity of the electro-dynamic action, which kept the needle from returning to its terrestrial line of repose.

If now we consider that the electro-magnetic force is equally distributed over every part of the wire forming the coil, it is obvious, that by passing the wire once round the compass-box, directly over and under the meridian line of the card, this force would be brought into play both on the upper and lower sides of the needle: and these two increments of force would conspire, and sustain the needle farther from the meridian line than either of them alone would do.



To familiarize the action which tends to the production of this fact, let us suppose the circles to represent transverse sections of the upper and lower portions of the wire; and that the source of electric action is a single pair of copper and zinc plates: then accordingly with what we have already shown, the current would flow *from* the end along the wire, (which imagine to be bent over the farther edge of the compass-box, behind the paper,) and return by the other end. This being understood, the right lines with cross heads will show the distribution of the polar lines of electro-magnetic force, due to the advancing and returning current. The *north* poles of the two portions of those lines which are situated immediately between the upper and lower parts of the wire, will be observed to be directed towards the spectator's right, and all the *south* poles of those lines, towards his left. And as the needle N S is placed between the upper and lower portions of the wire, it is influenced, principally, by those conspiring forces; and is sustained *out* of the magnetic meridian by their joint action.

In pursuing this illustration, we may now readily imagine, that by passing the conducting wire once round the compass-box, the electro-magnetic action on the needle would be double that which would be due to either the upper or lower part of the coil alone. This being admitted, two such coils would be productive of four times the single force, and three coils would multiply the force six times, and so on: and hence the name *multiplier* being given to this instrument. By this means, an electric current, whose force in one strand of wire alone would be too feeble to produce a perceptible motion of the magnetic needle, may easily be detected; sometimes by deflections of considerable extent.

Instead of employing a compass-box in the construction of a galvanometer, it is now usual to make an open oblong coil of thin copper wire, previously covered with sewing silk, in the manner that bonnet wire is covered. This silken covering is intended as an insulator, to prevent the electric current from passing laterally from one convolution to another. The number of convolutions in each coil varies with the different views of the contrivers, from ten to more than a hundred convolutions. For general purposes, perhaps about eighteen or twenty convolutions are quite sufficient. The convolutions are usually packed close together, and the coil fixed vertically on a board; and each extremity of the wire frequently terminates with a small cup, for the purpose of holding mercury, which is sometimes useful for connecting the instrument in the voltaic, or other electric circle. The needle may be of any shape the experimenter thinks proper. Perhaps long thin sewing needles, with the points and eyes cut off, answer as well as any. One of these, when magnetized, may be suspended in the centre of the coil, by means of a silken fibre, which passes through an opening in the upper side, as seen in fig. 3, or else supported on a pivot, as in fig. 2. A deep groove is usually cut in the base board, to place the lower edge of the coil in, and a graduated card for measuring the angles of deflection, is pasted to the surface of the board over the groove.

When the electric forces to be examined are but feeble, it will be better to employ two needles, with their like poles in opposite directions, as represented in fig. 5. The advantages derived from this arrangement are, that when the needles are of equal power, they will counteract each other's directive tendency, and obey the influence of an exceedingly slight electric action: and in consequence of their positions, with regard to the coil, they are both urged in the same direction, by the conspiring electro-magnetic forces to which they are exposed. The needles may be inserted in any light substance, as a thin straw, a piece of dry glass, or a narrow slip of card; and sustained by a silken film, as in the figure. This is called the *astatic* needle galvanometer. The angles of deflection are most conveniently read off, when the graduated card is placed on the upper side of the coil, the upper needle serving as the index. The astatic needle is the invention of the late Italian philosopher, the Chevalier Leopold Nobili.

As the electro-magnetic force is known to decline with an increase of distance from the conducting wire, another important point to be observed in the construction of these instruments when intended either for the detection, or the admeasurement of feeble electro-dynamic action, is, that the upper and lower sides of the coil should be no farther asunder than is necessary for the free motion of the needle between them; and the upper needle should be adjusted so as to move as close as possible to the coil. To prevent undulations of the air from disturbing the needles, the galvanometer should be covered with a glass shade. Although the appellation *galvanometer* is usually given to all the various forms of Schweigger's multiplier, many of them are obviously very far from being deserving of so dignified a title; and are of no farther use than that of indicating the mere existency of an electric current. Such instruments have sometimes been called *galvanoscopes*.

Dr. Ritchie's Torsion galvanometer, we believe, is not generally known, and as it possesses some peculiarities, a description of it will, no doubt, be interesting to many of our readers. The description is in the Doctor's own words, as we find it in the "*Journal of the Royal Institution of Great Britain, for October* 1830."

"In a paper which appeared in the first part of the 'Philosophical Transactions for 1830,' I investigated the elasticity of threads of glass, and applied that property to the construction of a delicate galvanometer. The instrument then described, though sufficient for most purposes, requires some modification to adapt it to researches of extreme delicacy. The description of the instrument, in its more perfect state, with a few of its numerous applications, will form the subject of this communication.

"For experimental researches in electro-magnetism, it is extremely useful to have constantly at hand, a quantity of copper wire, of different degrees of fineness, coated with sealing wax. The most convenient mode of giving the wire this coating is the following:—Stretch the wire between two supports, heat it gradually, from one end to the other, with an iron bar or spirit lamp, and continue rubbing the heated part with a stick of sealing-wax; the wire will receive a fine coating, sufficient to prevent metallic contact, when portions of it are pressed together in the construction of any piece of electro-magnetic apparatus.

"Take the wire thus coated, heat it slightly to prevent the wax cracking, and form it into a rectangular shape, consisting of six, eight, or ten repetitions of the wire, according to the delicacy of the instrument required. The upper side of the rectangle must then have the wires separated into two equal portions, bent round a small cylinder, and then continued straight, so as to leave a circular opening in the middle, about one-third of an inch diameter. The use of the circular opening in the upper side is to allow a slender axis, carrying the magnetic needles, to pass through it, in order to increase the power of the instrument, and render the compound needle astatic. Portions of a brass tube, about an inch long, are to be soldered to the ends of the wires forming the rectangle, for the purpose of holding a small quantity of mercury, to render the metallic contact complete. Figs. 6 and 8, exhibit a vertical section of the rectangle, and a horizontal one of its upper side.

"The wires forming the rectangle are pressed close together and secured by a waxed sewing thread, rolled tightly round them. The rectangle is then fixed in a rectangular box, having the upper side formed of two sliding panes of window glass, for the purpose of shutting up the needle from the agitation of the air. Each pane has a small semicircle cut out of middle of the edge, by means of a round file, so as to leave a circular opening directly above that in the rectangle. Various contrivances for suspending the magnetic needle might be adopted. The following is perhaps the most convenient:—Into a strong wooden sole or base, fix two upright supports, about three feet long. A small stage at the top, having a divided circle on its upper side, and which may be elevated or depressed at pleasure, completes the frame of the instrument. The stage has two holes of the same size as the supports, and at the same distance, with two small screws passing through its sides, opposite the centres of the openings [illegible] the purpose of fixing the stage securely at a proper height. A small cylindrical wooden key or peg, having a small bore in the axis, for the purpose of receiving the end of the glass thread, passes through the centre of the divided circle, and is made to turn easily, without much friction.

"After numerous trials, the following appears to me the best mode of preparing the threads of glass, so as to have their extremities somewhat thick and tapering, for the purpose of securing them in the Torsion key, and in the axis which carries the magnetic needles. Take a solid rod of glass, or a piece of a clean thermometer tube, having a fine bore, and draw out one of its ends as in fig 7. Direct the very point of the flame on the thick portion, and pull it out, between the two hands, to the proper length and fineness; at the first trial, it will be found necessary to draw several, and select the one best adapted to the purpose.

"Two slender darning needles, of the best steel, are then to be selected, the eyes to be broken off, and the ends filed to a point similar to the other ends, and then strongly magnetized in the usual way. The needles are then to be fixed transversely in a piece of straw or other light substance, about an inch long, and at the distance of about half an inch from each other, with their corresponding poles in opposite directions;—the one needle intended to be above the upper side of the rectangle, and the other below it. One end of the glass thread is then to be securely fixed in the end of the straw, or light axis, by means of strong cement or sealing wax, whilst the other extremity is fixed, in a like manner, in the centre of the Torsion key. A single fibre of silk, having a small weight attached to it, is fixed to the lower end of the axis, and made to pass through a small hole near the lower side of the rectangle, for the purpose of keeping the axis carrying the needles in the centre of the circular opening in the coil. The upper needle has two pieces of fine straw, several inches long, fixed on its ends, so that the slightest deflection may be readily observed. The extremity of one of the straws is made to oscillate between two upright pieces of glass, to prevent the needle moving over an extensive arc, and thus lengthen the time necessary to complete an observation. The whole will be obvious from the simple inspection of fig. 4, in which A B is the rectangular coil of wire; N S the magnetic needles; C the stage with the divided circle and Torsion key; and G the glass thread. If instead of the glass thread the needle be suspended by a single fibre of silk, the instrument becomes a galvanoscope of extreme delicacy. The following experiment affords a striking illustration of the extreme sensibility of the instrument with this modification:—File off a few grains from a piece of zinc and copper, by means of a coarse file; place two of these near each other, in the bottom of a clean watch glass, bring the clean ends of two fine copper wires, connected with the cups of the galvanometer in contact with them, and then drop over them a small quantity of dilute acid, and the compound needle will be deflected several degrees.

"The instrument by which I ascertained the existence of a voltaic current from this elementary battrey, consisted of a greater number of coils in the rectangle, and the needles were light and strongly magnetized."

Galvanometers used by Dr. Faraday.—Two galvanometers, which have been employed in a great variety of important experiments, are described as below, in the 78th and 205th articles of Dr. Faraday's "Experimental Researches in Electricity." Phil. Trans. for 1832.

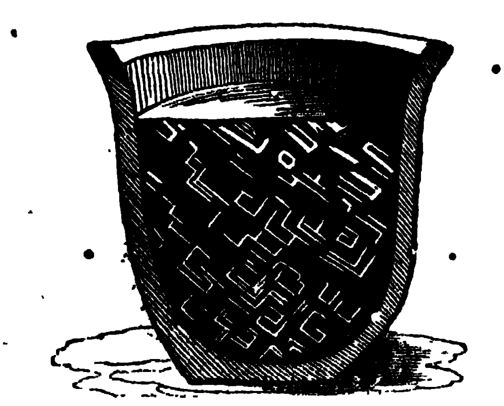
Article 78.—"The Galvanometer was roughly made, yet sufficiently delicate in its indications. The wire was of copper covered with silk, and made sixteen or eighteen convolutions. Two sewing needles were magnetized and passed through a piece of dried grass parallel to each other, but in opposite directions, and about half an inch apart; this system was suspended by a fibre of unspun silk, so that the lower needle should be between the convolutions of the multiplier; and the upper above them. The latter was by much the most powerful magnet, and gave terrestrial direction to the whole.

Article 205.—" To obtain perfectly satisfactory results, a new galvanometer was constructed, consisting of two independent coils, each containing 18 feet of silked copper wire. These coils were exactly alike in shape and number of turns, and were fixed side by side with a small interval between them, in which a double needle could be hung by a fibre of silk exactly as in the former instrument. When electrical currents were sent through them in the same direction they acted upon the needle with the sum of their powers, when in opposite direction with the difference of their powers."

CRYSTALLIZATION OF BISMUTH.

Bismuth melts at 476°, and if allowed to cool slowly, it crystallizes in parallelopipedons which join or rather meet at a right angle and are enveloped in one another like the turns of a volute, such as are termed à la Grecque, because the Greeks have often employed this form in architecture. In order to obtain this crystallization, we must wait till the bismuth is fixed at its surface; then perforate the crust and pour off the fluid portion, not in order to leave a space sufficient for the regular arrangement of the molecules as Romé de Lisle imagined, for the crystals are formed in the midst of the liquid metal like the salts in their solution, but in order to lay bare the crystals that are already formed, and not suffer them to be inclosed in the whole of the fixed metal. M. Pouget has actually observed that when the solid crust formed at the surface of the fused bismuth is taken away whilst the lower part is still liquid, this crust exhibits well-formed crystals beneath. Of all the metals this crystallizes in the most regular and easy manner.

Dr. Reid observes, " melt some bismuth in a crucible when the surface becomes solid, and while the greater part of the metal is still melted within, make a small hole in the middle and invert the crucible till all the liquid metal has been poured out. On breaking into the hollow mass that is left, its internal surface will be found studded with crystals of metallic bismuth."



Another method is to melt the bismuth in an iron ladle, cooling the bottom by immersing it in cold water before breaking the crust above, and taking care not to allow any water to fall upon the melted metal, least some of it should be thrown about with explosive violence.

PRIMING AND PREPARING CLOTH FOR THE ARTIST.

From the time that the restoration of the arts in Italy commenced, down to the days of Raffael, panels were always used for painting on, except when the works were to be fixed to a particular place. Canvasses united the advantages of cheapness and easy removal. The latter, therefore, gained a preference; and after Raffael's time they no longer painted large pictures on wood in Italy.

In the Low Countries the use of panels continued much longer. Even in the time of Rubens there was, at Antwerp, a celebrated manufactory, where the panels were prepared of great dimensions; but after the death of the chief artist of the Flemish school, the artists painted only easel pictures on wood.

The Italians preferred poplar wood for this purpose. In Flanders oak was used; as it is very seldom injured by worms.

It is natural to suppose, that panels composed of several pieces glued together, might become disunited by the changes arising from dryness or moisture, to which pictures are always more or less subject. To prevent these accidents, very great care was taken in the earlier times, but latterly these precautions were neglected; bands of linen were glued upon the joining, and even occasionally they covered the entire surface of the panel with black tanned leather; the glueing on of linen bands, is attributed by *Vasari* to *Margheritone*, who lived in the twelfth century, but it was known before his time, for the practice is described in Theophilus' treatise, *De arte Pingendi;* it was probably brought into Italy by the Greeks.

In the commencement of the art the canvasses were prepared like the panels with distemper grounds; and generally the pictures of Paul Veronese were painted upon such primed cloths.

The practice now is, to prime the cloth with oil color, changing the mode according as the canvass is of a closer or more open texture. When the canvass is very open, and lets the color through, it must be saturated with size made of glove parings, laid on with a large palette knife or trowel, the edge of which should be blunt, and as straight as a rule, that the couch of size may be laid as evenly as possible; when the priming is quite dry, it must be rubbed with pumice stone, to make it free from lumps; then with the knife, a couch of ceruse is applied; when dry this is also pumiced; a second couch is then put on, and sometimes a third, to obtain a perfectly even surface.

Formerly, the first priming was made with dark red, mixed with umber, or with pure umber; and some sixty years since, it was supposed, that the drying of this color would be quickened by mixing it with litharge; but it has been discovered that pictures painted on these sorts of preparations, in a few years have their surfaces covered with a multitude of little grains like sand; and thus proving that the litharge was badly prepared.

At the present day, the artists are more careful in such essential matters; and the colormen, for their own sakes; are excited to prepare their canvasses with more attention, for any negligence in these essential matters would ruin their trade.

Cloth for priming without sizing, ought to be of a closer and more even texture; in this respect ticking is peculiarly advantageous; for though at present it is not to be had of a much greater width than two yards, yet, if the manufacturers found a demand for it, they, no doubt, would make it up to any reasonable dimensions. If the cloth is not sized, it will require three or four couches of color to ensure an even surface; and before a new couch is applied, time must be allowed for the former to dry hard enough to be rubbed with pumice; this is the reason why cloth requires, in preparation, two or three months in summer, and five or six in the winter season.

The time required for priming may be shortened very much, by making the first and second couches with distemper; and as soon as they are quite dry, and pumiced into an even surface, let the last couch be merely oil which has become viscous by exposure to the air: this will penetrate the distemper, and render it quite pliant. By the former method, much time is required to dry the cloth. But by this mode, as soon as the oil is absorbed, they may be rolled up like waxed cloths, with perfect safety. As the pliancy of these cloths depends upon the complete union of the oil with the distemper, the absorption would be greatly facilitated by using a very weak size, mixed with a little oil, and a good quantity of mucilage of linseed meal, or the latter mucilage alone will do if well boiled.

This species of ground may be made in four or five days, which will economise the time considerably. It is even pretended that a picture may be commenced immediately upon one of these grounds when fresh prepared, and that the colors will change much less than they do when used on a well-dried ground; but such is not the general opinion: for the viscous oil used in the ground, and to which the cloth owes its pliancy, dries but slowly. Hence the colors, being left too long exposed to the chemical action of the oil, are likely to undergo a change. Therefore if circumstances compel artists to paint on such a ground when fresh, they would do well to apply a strong couch of white chalk with a little size in it, to absorb the excess of oil; but it would, in such a case, be still better to paint on a distemper ground.

IMPROVED PAPIER-MACHE.

Mr. Bielefeld has published a very interesting memoir on the origin of papier-mâché, the causes of its improvement, and its re-introduction for the decoration of the interior and exterior of houses.

The application of steam-power, and the vast improvement, of recent date, in all branches of mechanical science, have enabled Mr. Bielefeld to produce a material similar, in name only, to the papier-mâché of the last century: its hard compactness, strength, imperishable nature, lightness, and tractability, (if such an expression may be allowed,) the facility and quickness with which it may be prepared, put together, and fixed up, and, finally, its cheapness, are qualities which eminently distinguish it, but which cannot, perhaps, be fully appreciated, excepting by those who have had professional experience in its application. Among the latter, to the architect, builder, and house-decorator, the most extensive opportunities are offered for the employment of Mr. Bielefeld's papier-mâché; inasmuch as not only all the forms of ornament commonly in use may be executed with it, in every way superior to that with any other material, but its particular qualities are such as to extend the field of invention immeasurably beyond the limits to which it has hitherto been confined. To assert that whatever has been attempted in stucco may be accomplished with the greatest facility in papier-mâché, would be very inadequately expressing its capabilities. Whatever the genius of Grinlin Gibbons induced him to attempt in wood, may be effectively performed in papier-mâché, with no less sharpness, no less relief, no less lightness, and much less liability to injury; papier-mâché having this great advantage over wood, that, although as hard, it is tougher, and is wholly without the grain in wood, which gives it a bias or tendency to chip off in one direction; but with papier-mâché it is wholly different; no matter in what direction a blow falls, nothing but destructive violence will damage it.

In architecture and interior decoration, papier-mâché is advantageously used. Nothing can possibly be more to the purpose, in cases where an old, plain, plaster-ceiling, has to be rendered ornamental by the application of panels, pateras, &c.; without disturbing the ground of the ceiling, every kind of enrichment can thus be applied to the surface; and so trifling is the weight of these ornamental additions, that old laths and ceiling-joists can receive them with perfect safety. A new cornice, dry, and ready to color, can thus be fixed up against an old ceiling, without the delay, rubbish, and dirt, attendant on running a plaster cornice; indeed, without the removal of a single article of furniture, an old ceiling can, in a very few hours, be made, if desired, to assume an entirely new aspect. By the same means, old plain stuccoed walls can be paneled, or otherwise enriched, with equal convenience and despatch. When, from the lapse of time, or other cause, the enrichments on an old stuccoed or carved ceiling have fallen to pieces; or when, as is not unfrequently the case in works of even recent date, plaster ornaments have detached themselves from the ceiling by merely the operation of their own weight; the injury is repaired in papier-mâché with perfect success; ornaments of great boldness and projection being thus applied to the face of the old work without the least risk, and when, perhaps, the timbers are so slight as to make heavy plaster ornaments highly dangerous. In the completion and decoration of new buildings is a further unlimited range of ornamental purposes to which papier-mâché is applicable. Columns of every order and degree of enrichment, including not only the capitals and bases, but the entire shafts, whether fluted in the classic style, or fretted over with arabesques, as in the Cinque-Cento and Elizabethan styles; caryatides, termini, and chimera; are all produced with great facility and but slight cost.

Ceilings, especially, are wholly within the mastery of the manufacturer: those at the Pantheon, in Oxford-street, and Grocers' Hall, near the General Post Office, in London; the vice-regal state rooms of Dublin Castle, and others, which may be referred to, display, in some measure, what may be achieved in papier-mâché: yet these, superior as they are in general effect, are specimens of but trivial significance in comparison with the powers and capabilities of the material in the gorgeous details of the magnificent ceilings of the age of Louis Quatorze, which can be fully and permanently executed; and as there is established evidence of the durability of papier-mâché in the open air, it of course follows, that in all interior decorations its indestructible quality may be still more implicitly relied on.

For gallery-fronts, altar-pieces, organ-cases, and other ornamental parts of churches and chapels, papier-mâché has now become generally adopted: nor is its use confined to these more important works; many hundreds of pateras or flowers are annually fixed up on ceilings of the smaller class of private dwellings, in almost every town of the kingdom. Flowers are, further, extensively employed in covering the apertures for ventilation in the ceilings of churches, chapels, and places of public resort: plaster flowers being only with much difficulty, and often times with danger, fixed up in these situations. The wreaths, or enriched bands, which frequently encircle these flowers, are also most effectively and elegantly formed of papier-mâché. Another very usual mode of giving enrichment to rooms in the modern style, is to connect with the cornice some guilloche, or fret, upon the face of the ceiling, and, where still more effect is required, adding a frieze under the cornice, against the face of the wall. As in forming these enrichments, the ground is first finished plain, and the foliage in the papier-mâché then laid upon the face, it is obvious, to the practical man, that a clear relief and distinctness of outline is thereby obtained; quite unattainable in plaster work, where the enrichment is cast with the ground.

Brackets, consoles, and cantilivers, in numerous and tasteful varieties, are made of this substance; and indeed, one of the earliest applications of Mr. Bielefeld's improved papier-mâché to architectural purposes, was the formation, on the accession of William the Fourth, of several large consoles and cornices, in the state apartments of St. James's Palace. Since that time, similar enrichments have been supplied, by the manufacturer, to Grocers' Hall; King's College, Strand; the Carlton Club, and the Oxford and Cambridge Club Houses, in Pall Mall; the British Museum; the State Rooms in Dublin Castle; the Grand Masonic Lodge, Freemasons' Hall; the Corn Exchange; and other public buildings.

Nor need its application be limited to interior decorations. At Paris, the Carton-Pierre, a substance analogous to papier-mâché, but in every respect inferior, especially as regards durability, being very absorbent of moisture, and, consequently, liable to become soft, is largely used for exterior ornaments, even in buildings of the most sumptuous and important character. Not so the papier-mâché of English manufacture; as even that of the last century is found, on inspection, to afford abundant proofs of its extreme tenacity in exposed situations. The papier-mâché which enriched the fanciful architecture at the back of Sir William Chambers's house, in Berners Street, Oxford Street, now nearly three-fourths of a century old, is still in perfect condition. Mr. Bielefeld's improved papier-mâché is of too recent introduction to afford a reference to any example of its adoption in exterior work beyond fourteen years; but several shop-fronts in the metropolis, fitted up of that material, have at this hour their papier-mâché enrichments as sound, sharp, and perfect, as when first turned out from the mould.

Another and most important use to which the improved mâché may be applied, is that of rendering in duplicate forms the emanations of the sculptor's skill: for whilst any piece of sculpture can be made in fac-simile with perfect fidelity, the weight is scarcely one-sixth that of plaster, and the liability to injury or fracture is in no way to be compared with copies or repetitions in either marble, stone, or wood; whilst the economy of price places the papier-mâché specimens beyond all reach of rivalry; as all being finished with equal minuteness and care, they have only to be colored in representation of the marble originals.

Papier-mâché is applied by the cabinet-maker and upholsterer, with surprising effect, to the enriched cornices of book-cases and cabinets; to the mouldings, corners, and centre ornaments of paneling on their doors and sides; to the enriched scroll legs of cabinets, and pier tables, in the old French style; to ornamental brackets for clocks, busts, vases; to the enriched borders of rooms hung with silk or paper; the ornamental parts of picture and glass frames, however curved and elaborate in their form; and, also, to window-curtain cornices, the canopies of bedsteads, &c.

With regard to the mode of fixing papier-mâché in cabinet work, the simplest and most correct rule is, to treat it as if it were wood, and fasten it by means of brads, needle-points, or glue. It is to be cut with a saw and chisel; and may be bent by steam or heat, planed, and cleaned up with sand paper to the smoothest face, and to the finest arris, if required. The larger objects, such as brackets and canopies, can be made either with a wood core, or wholly of papier-mâché: in either case two or three screws secure them in their place. When fixed, the work can be painted and grained without any previous preparation; and, in gilding, the surface of the work is better adapted to receive the gold than that of any other material; much of the expense and delay usually attendant on the process being thereby saved. The same observation applies to silvering; and, it may be added, the metallic leaf continues untarnished on papier-mâché for a greater length of time than on other substances, as may be proved by the specimens at Chesterfield House, and other houses of the nobility.—*Abridged from the Literary World*, vol. iii.

GLAZING EARTHENWARE AND CHINA.

The glaze usually employed for common kinds of earthenware is compounded of litharge of lead and ground flints, in the proportion of ten parts by weight of the former to four parts of the latter. Cornish granite is sometimes substituted for flint, and used in the proportion of 8 parts to 10 of litharge. This method of glazing is objectionable on account of the injury which, notwithstanding every precaution that can be taken, it occasions, in its application, to the health of the workmen employed, who frequently are seized with paralysis; and because the lead, which is soluble by means of acids, and highly poisonous, renders vessels thus glazed improper for preparing or containing human food.

The mixtures just mentioned are called raw glazes: their employment is convenient to the potter because of their cheapness and extreme fusibility. Flint, which remains unaffected in the focus of the most powerful lens, is, when combined with lead, melted and vitrified at a comparatively low heat. The mixture must be well stirred, that the powders may be always kept uniformly blended throughout the fluid. The pieces are first brushed to free them from dust, and then merely dipped into the liquid and withdrawn, when they must be turned rapidly about in all directions, that the glaze may flow equally over the whole surface. The superfluous liquid having been allowed to drain off for a few seconds, and the pieces having been set on a board during a few minutes, they are ready for insertion in the furnace.

Chaptal, in his "Chemistry applied to the Arts," has given a process for forming white enamel, which answers well for glazing the superior kinds of earthenware and tender porcelain. Equal parts of lead and tin are kept in fusion until completely oxidated. The powder thus formed is ground with water, all impurities are removed by repeated washings, and being dried it is kept for use. The whitest flints are then chosen, and fused with carbonate of potash, the latter being in such proportion to the flint, that the mixture will be soluble in water. To the solution of flint thus made, muriatic acid must, from time to time, be added, until no further precipitation occurs. The precipitate thus obtained is pure silex, which being washed and dried, is also fit for use. If then one part of this silex, and one part of the metallic oxide, be added to two parts of carbonate of potash, and the whole be fused in a crucible, the mass need only be reduced to a fine powder to prepare it for use in glazing.

Mr. John Rose, of the porcelain works at Coalport in Shropshire, speaks in commendation of a glaze for hard porcelain which he has used for some time, and which having been examined by competent artists, at the request of the Society of Arts, has been reported on very favorably. Mr. Rose's glaze is composed of 27 parts of felspar, 18 of borax, 4 of Lynn sand, 3 of nitre, 3 of soda, and 3 of the china clay of Cornwall. This mixture is melted together and ground to a fine powder; 3 parts of calcined borax being added previously to the grinding.

Glazes for porcelain and the finer kinds of earthenware are generally made with white lead, ground flints, ground flint glass, and common salt; Lynn sand combined with soda, as a flux, being frequently added to the ingredients just mentioned. Almost every manufacturer uses a peculiar glaze, the recipe for which is kept secret by him as much as possible, under the idea of its superiority compared with that employed by his competitors, so that it is not possible to state proportions with accuracy. The French porcelain makers have given the composition of hard glazes made by them, which are all said to be formed of flint, ground porcelain, and crystals of calcined gypsum, in the following different proportions:—

	No. 1.	No. 2.	No. 3.
Calcined flint	8 pts.	17 pts.	11 pts.
Ground porcelain. . . .	15	16	18
Crystals of calcined gypsum	9	7	12

It is necessary to vary the composition of the glaze, in order to suit the different materials that form the body of the ware, since that would be a very fine glaze for one mixture of earths, which would be wholly inappropriate to another, proving deficient in lustre and being liable to crack. Before adopting any glaze in conjunction with a particular kind of ware, it is most prudent to make trial of it upon a small scale, in order to prove the suitableness of the bodies to each other.

So great is the competition among potters in the present day, that means which are injurious to their real quality are frequently adopted for rendering their wares less costly. Some makers are hence tempted to the employment of materials that will enable them, at a moderate price, to furnish articles apparently good, but which will speedily prove defective when brought into use. The saving which the manufacturer is able to effect, through the adoption of an inferior glaze, consists not so much in the actual cost of its component parts, as in the smaller quantity of fuel required for its vitrification, and in the shorter period of time demanded for its conversion.

The earthenwares offered, at low prices, by hawkers and pedlers, and at inferior shops, are mostly composed of clay that will not bear a proper degree of heat in the oven, and are covered by a glaze so tender as to craze after a few cleansings with hot water. If exposed to a high temperature, or if acids be applied, the glaze will be dissolved, and the vessels consequently rendered useless. The quantity of lead which enters into the composition of the better kinds of glazes is so small, that the deteriorating and pernicious effects which attend upon the use of raw glaze need not be apprehended from their employment.

As alkaline substances are so powerfully instrumental in promoting the fusion of intractable bodies, it may be thought, that by increasing their proportion when combined with felspar, glazes might be formed that would fuse at a heat sufficiently moderate for any description of earthenware, and that, consequently, the use of oxide of lead, which is so pernicious, might be altogether abandoned: but another serious evil which would then be experienced prevents this substitution. The glaze, if it contained, beyond a certain portion of alkali, would not undergo the same degree of expansion by heat as the body whereon it is laid, and would, as a consequence, crack to such a degree as, when brought into use, would allow any greasy matter to penetrate through to the body of the ware; and this would speedily destroy its coherency.

The qualities which it is the object of the manufacturer to give to porcelain of the finest description, are density, whiteness, transparency, and fine texture of the glaze. These properties are estimated in the order wherein they are here enumerated, compactness of body being the point which it is considered most desirable to attain. The glaze, as seen in the finished porcelain, should not put on a lustrous appearance; but while beautifully smooth to the touch, should present to the eye rather the softness of velvet than the gloss of satin. This peculiar semblance will only be produced with glaze that melts with difficulty, and when the heat has been raised precisely to, and not beyond, the point that is necessary for its fusion.

The glazing of common red ware is effected by the decomposition of common salt thrown into the kiln, at or near the conclusion of the baking process. Other glazes are likewise employed for many articles, and, according to the usual system, the particular components of these are also veiled in mystery; ground glass is, however, understood to be the basis of all.

The different colors observable on the outer surface of drinking jugs and other articles, is owing to the partial use of a glaze, the part to which this is applied becoming dark in the heat of the kiln, while the glazing of the light colored portion is caused by the introduction of salt.

NOTES ON THE MONTH OF MAY.

Weather at	*Average of the Thermometer.*	*Average of the Barometer.*	*Quantity of Rain.*
London	56 61	30·02	0·794
Edinburgh....	50·4	29·585	1·945
Dublin.......	52·19	30·061	1 812

In this month animals of all kinds are in full vigour. The beasts enjoy themselves in the fresh pastures. The groves resound with the songs of the feathered race. The reptiles and dormant animals, as the season progresses, and the air becomes warmer, break from their winter's torpidity. Trees and pools swarm with insect life. Fish again become active, and fill the streams with their spawn. Trees blossom, vegetation rapidly proceeds, flowers enamel the meads and hedge-rows, and all nature seems to smile. Man finds his spirits improve, his vigour increase; his agricultural labours occupy his attention, and he returns to them with renewed attention and zest, urged on by the united stimulants of health, profit, and pleasure.

ANIMATED NATURE.

Leverets and young Rabbits are now first seen gamboling in the copses and among the young crops in the fields. The Cuckoo is heard early in the month. The Chimney Swallow, the Swift, the Martin or Martlet, and others of the Swallow tribe return to us again. The Corn Crake and the Night Jar make their discordant noises. The Titlark sings. The Goldfinch, the Blackbird, and the Thrush make the groves re-echo with their varied melody, and towards the end of the month the Nightingale may be heard in the forest. The Dove and Pidgeon coo, the Redbreast, the Willow Wren, the White Throat, the Grasshopper Lark, and the Goatsucker return from other climes, to spend their summer with us, and towards the end of the month the Great Bat flutters in the evening. Reptiles, the Frog, Snake, Eft, and Lizard are, if the weather be warm, tempted from their winter quarters, and lay their slimy spawn, the first in ponds, the rest under dunghills or warm walls.

Fish sport up and down the streams, and find abundance of food in the larvæ of numerous insects and worms, and shelter for their spawn amidst the young and growing water-plants. Snails and Slugs appear in the gardens. Earth-worms are abundant. The Cockchafer or Mayfly abounds on the trees. The Libellulæ or Dragonflies sail over the pools. The Ladybird, or Ladycow, the Green Aphis, and the White-cabbage Butterfly are of constant recurrence in the gardens.

VEGETABLE LIFE.

In the fields, the Botanist will see many of his favorites appearing again, while those of winter are not yet over. The Mosses are still in perfection; indeed for most of them this is the best season. The Bryums are now particularly fine; so are the Gymnostomums, the Tortulas, the Polytrichums, and the Phascums. Algæ are now in vigorous growth, but not yet fertile. Lichens are decaying, or rather becoming dormant till the damps of the following autumn shall again urge their further growth. Fungi also are no longer abundant, though many of the Polypori are yet to be found, and indeed numerous others on decaying plants in damp situations. Flowering plants are seen every day to put forth fresh blossoms, though it is not till the end of the month that the real beauty of summer is fully established. In the earlier part of the month various of the Dead Nettles, the Pilewort, the Caltha Palustris, the Daisy, the Dandelion, the Ground Ivy, various of the early Speedwells, the Blackthorn, and the Shepherd's Purse, are almost the only common plants. Towards the latter part of the month, the collection is greatly increased both in number and in beauty. The trees are in their greatest perfection. The Sycamore and Maple, the Chestnut, the Hawthorn, (emphatically called the May,) the great tribe of the Willows, the Furze, the Pine, and Fir, the Poplar, the Barberry, the Iris or Corn Flag, the Lily of the Valley, the Guelder Rose, the Columbine, the Buttercup, the Plaintain, the Wallflower, the Forget-me-not, the Water Violet, Milkwort, and numerous others. Some of these, though indigenous in our islands, are brought into our gardens, where they flourish, yet not with greater beauty than in their native wilds. The garden at this season is still in its infancy, yet begins to put on its summer dress. The Lilac, Anemonies, Ranunculus, Auriculas, and the Polyanthus tribe are now in perfection. Peonies, the Crown Imperial, the Tulip, the Jonquil, and numerous other bulbs, are in full flower, and aided by the Azalea, the Fruit Trees, the Early Heaths, the Horse-chesnut, the Tulip Tree, the Draba, and the Aubletia, and other no less beautiful trees and plants, make the garden gay long before its seedlings and the majority of its herbaceous plants show any signs of beauty.

GARDENING OPERATIONS FOR THE MONTH.

Pruning and Transplanting of Trees and Shrubs is now over for the season, and the general Summer Crops are sowed and planted; the digging up of the borders is completed, yet much remains for the gardener to attend to. Weeds at all times are to be eradicated; and if frosts prevail, as they often do in the early part of the month, the young and tender Radishes and Lettuces must be defended by straw or other matting. Sowing and Planting of Culinary Vegetables is still to be continued at intervals to obtain a succession of crops. Sow at intervals of a fortnight, Spinach, Radishes, Small Salad, Peas, and Beans; Carrots for late drawing; Borecole, Dwarf Kidney Beans for a main crop, Cauliflowers, Onions, Savoys, &c., may still be sowed. Strawberries transplanted. Their runners must be nipped off, and the suckers of all trees and bushes, except Raspberries, rooted up. Sow Capsicums and Tomatas on warm borders; and Pumpkins, Melons, Cucumbers, &c. in the frames.

In the Flower Department of the garden, many of the more hardy Annuals and Biennials which have been sowed under glasses, may be transplanted—such as Ten-week Stocks, China Aster, Tobacco, &c.; and the sowing of the various kinds of border flowers be continued for a succession of crops during the summer, such as Mignionette, Virginia Stock, Indian Pink, Poppies, Convolvulus, and others. Such bulbous and tuberous roots as still remain out of the grounds must be planted as early as possible, such as Dahlia, Commellina, &c. In the Nursery Grounds, the seeds of Biennials should be sowed—of Wallflowers, Canterbury-bell, Rocket, various Stocks, &c., and numerous of the Potherbs, and Flowering Plants and Shrubs may be propagated by cutting or parting the roots. The young plants now springing up will require watering if the weather be dry, and the earth about them loosened.

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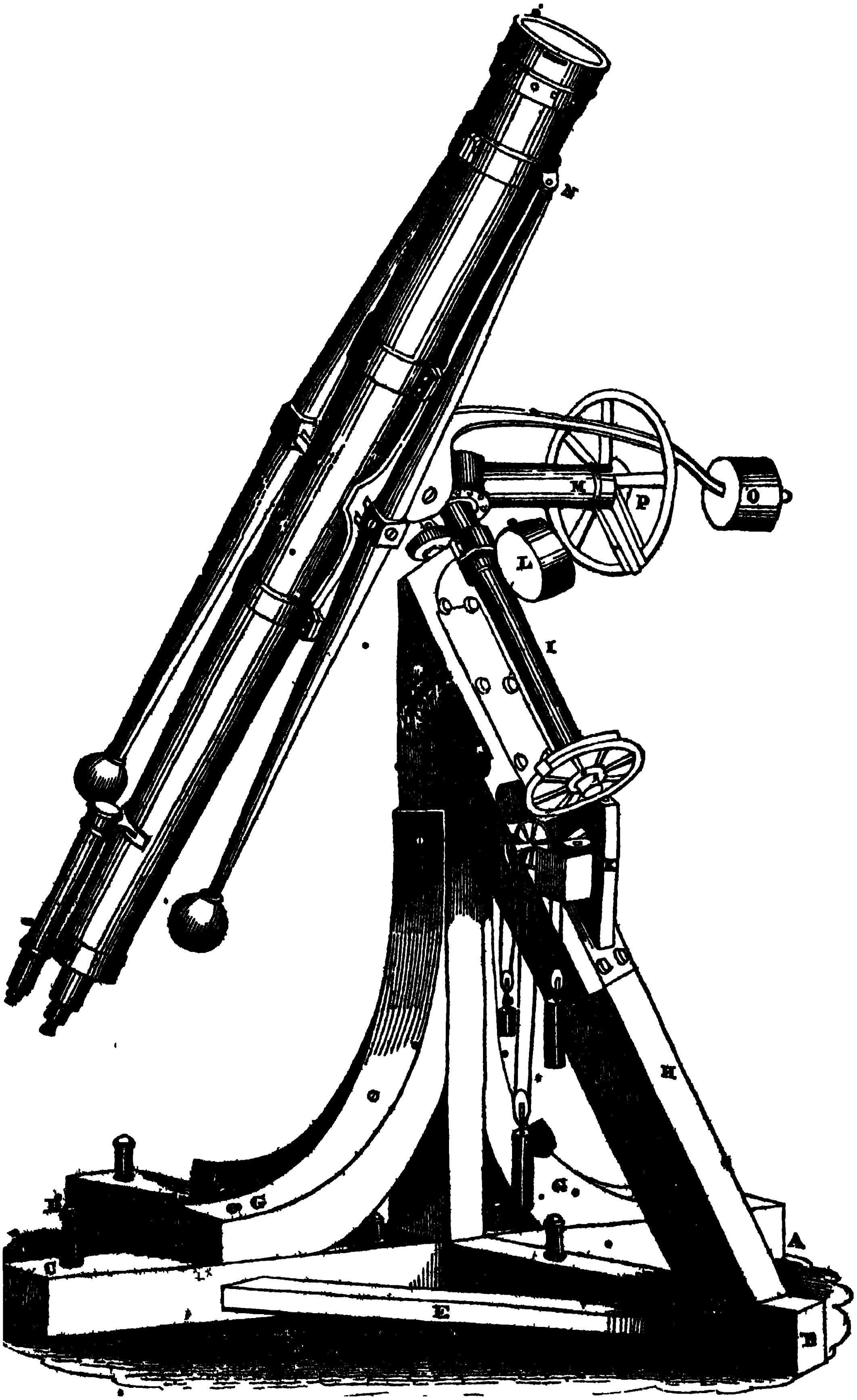


FRAUNHOFER'S DORPAT TELESCOPE

DORPAT TELESCOPE.

The late Joseph Fraunhofer, of Munich, a most skilful artist and experimenter in optics (whose demise in 1826, in the prime of life, was a great loss to science), constructed a magnificent refracting telescope for the observatory of the Imperial University at Dorpat. It was received by Professor Struve, in the year 1825, and has since been found to fulfil most satisfactorily his expectation and the intentions of the maker. As this is one of the most magnificent instruments of the kind that has hitherto been constructed, and described by a figure, we have given an engraving of it, copied from the "Memoirs of the Astronomical Society."

The object-glass of this telescope is about 9½ inches in diameter, and its focal length about 14 English feet. The main tube is 13·8 feet; and, in addition, there is the small tube which holds the eye-pieces. Of these there are four; the least magnifying power is 175, and the greatest 700. After the telescope was received at Dorpat, a perfect micrometrical apparatus was ordered to be made for it. This was to consist of four annular micrometers, of which two were to be double; a lamp circular micrometer, with four eye-pieces; a refracting lamp net micrometer, with position circles, and four eye-pieces.

The frame-work of the stand is made of oak, and the tube of deal, veneered with mahogany. The whole weight of the telescope and its counterpoises is supported at one point, namely, at the common centre of gravity of all the ponderous parts. These weigh 3000 Russian pounds, of which the frame-work contains 1000; the remaining 2000 are so balanced in every position, that the telescope may be turned, with rapidity and certainty, in every direction towards the heavens.

The basis of the frame is formed of two cross beams, each 9 feet 7 inches long. The ends of these are seen in the figure at A, B, C, D. They are braced by four smaller bars, forming a square, one of which is seen at E. This braced cross is fastened to the floor by eight screws, 6 of which are seen in the figure. A perpendicular post, about 6 feet high, and 7 inches square, is fixed over the centre of the cross, and is propped at the north, east, and west sides by three curved stays, denoted by G, G, G, which are fixed at their lower ends to the beams of the cross, and at the upper to the vertical post. An inclined beam H of the same thickness rests on the southern side of the meridian beam of the cross, and is attached to the vertical beam in a position parallel to the polar axis. This axis, shown in the figure at I, is a cylinder of steel, 39 inches long, and proportionally thick. It turns in two collars, and its lower end, which is rounded and polished, rests on a steel plate attached to the bearing piece K, which is secured to the inclined beam H, and has, therefore, very little friction, the weight being supported by friction rollers near the common centre of gravity; and a counterpoise L is applied, to support the axis in any position. There is a circle, 13 inches in diameter, graduated to minutes of time, fixed to the lower end of the axis, and furnished with verniers. The axis of vertical motion of the telescope, which has nearly the dimensions of the polar axis, passes through a brass tube at right angles to the latter; the tube, which is seen at M, forms a part of the frame, and is fastened at the upper end of the polar axis by twelve screws. This axis carries the circle of declination, which is 19 inches in diameter, and is divided to every 10′, with a vernier reading 10″ or 5″ by estimation. The tube of the telescope is fixed to the frame-work nearer to the eye end than the middle, and has two counterpoises attached to levers, which balance the two ends, and prevent the natural tendency of the longer end to bend. The brass frame holding the two axes appears on the figure clamped to the tube by two strong rings, one at each end of the centre of motion. A bent lever, carrying the weight O, embraces, by a double ring, the near end of the axis of the declination circle. The axis itself carries another weight; and by this and the weight O it is counterpoised. The slow motion in altitude is given to the telescope by a joint applied to the screw of the clamp, which has a spring urging it against a strong iron bar P, attached to the end of a cylinder M, that forms a stop to the circle; and a slow equatorial motion is given by a second joint taking hold of an endless screw, acting with the racked edge of the hour circle, while a spring presses it into action uniformly, and a lever is employed to raise it out of the rack when necessary. The handles taking hold of these screws extend to the reach of the observer, who can thus point his telescope in right ascension and declination with the same certainty as the best meridian instrument.

A regular sidereal motion is communicated to the instrument by clock-work, which keeps a star apparently at rest in the centre of the field of view; and there is a contrivance by which the sidereal can be changed into a solar, also to a lunar angular motion.

This almost invaluable instrument cost 10,500 florins (about 950 pounds sterling). The price, although it may appear considerable, yet barely covered the expenses of the workmanship of its construction. This relinquishment of the profit of trade does great credit to the ingenious and liberal-minded artists, Fraunhofer, and Utzchneider, the chief of the optical establishment at Munich.

THE TIDES.

One of the most immediate and remarkable effects of a gravitating force external to the earth, is the alternate rise and fall of the surface of the sea twice in the course of a lunar day, or 24 hours, 50 minutes, 28 seconds of mean solar time. As it depends upon the action of the sun and moon, it is classed among astronomical problems, of which it is by far the most difficult, and its explanation the least satisfactory. The form of the surface of the ocean in equilibrio, when revolving with the earth round its axis, is an ellipsoid flattened at the poles; but the action of the sun and moon, especially of the moon, disturbs the equilibrium of the ocean. If the moon attracted the centre of gravity of the earth and all its particles with equal and parallel forces, the whole system of the earth and the waters that cover it, would yield to these forces with a common motion, and the equilibrium of the seas would remain undisturbed. The difference of the forces, and the inequality of their directions, alone disturb the equilibrium.

It is proved by daily experience, as well as by strict mathematical reasoning, that if a number of waves or oscillations be excited in a fluid by different forces, each pursues its course, and has its effect independently of the rest. Now, in the tides there are three kinds of oscillations, depending on different causes, and producing their effects independently of each other, which may therefore be estimated separately.

The oscillations of the first kind, which are very small, are independent of the rotation of the earth; and as they depend upon the motion of the disturbing body in its orbit, they are of long periods. The second kind of oscillations depends upon the rotation of the earth; therefore their period is nearly a day. The oscillations of the third kind vary with an angle equal to twice the angular rotation of the earth, and consequently happen twice in twenty-four hours. The first afford no particular interest, and are extremely small; but the difference of two consecutive tides depends upon the second. At the time of the solstices, this difference, which ought to be very great, according to Newton's theory, is hardly sensible on our shores. La Place has shown that the discrepancy arises from the depth of the sea; and that if the depth were uniform, there would be no difference in the consecutive tides but that which is occasioned by local circumstances. It follows, therefore, that as this difference is extremely small, the sea, considered in a large extent, must be nearly of uniform depth; that is to say, there is a certain mean depth from which the deviation is not great. The mean depth of the Pacific Ocean is supposed to be about four miles, that of the Atlantic only three, which, however, is mere conjecture. From the formulæ which determine the difference of the consecutive tides, it is proved, that the precession of the equinoxes, and the nutation of the earth's axis, are the same as if the sea formed one solid mass with the earth.

Oscillations of the third kind are the semidiurnal tides so remarkable on our coasts. They are occasioned by the combined action of the sun and moon; but as the effect of each is independent of the other, they may be considered separately.

The particles of water under the moon are more attracted than the centre of gravity of the earth, in the inverse ratio of the square of the distances. Hence they have a tendency to leave the earth, but are retained by their gravitation, which is diminished by this tendency. On the contrary, the moon attracts the centre of the earth more powerfully than she attracts the particles of water in the hemisphere opposite to her; so that the earth has a tendency to leave the waters, but is retained by gravitation, which is again diminished by this tendency. Thus the waters immediately under the moon are drawn from the earth at the same time that the earth is drawn from those which are diametrically opposite to her; in both instances producing an elevation of the ocean of nearly the same height above the surface of equilibrium; for, the diminution of the gravitation of the particles in each position is almost the same, on account of the distance of the moon being great in comparison of the radius of the earth. Were the earth entirely covered by the sea, the water thus attracted by the moon would assume the form of an oblong spheroid, whose greater axis would point towards the moon, since the columns of water under the moon and in the direction diametrically opposite to her, are rendered lighter in consequence of the diminution of their gravitation; and in order to preserve the equilibrium, the axes 90° distant would be shortened. The elevation, on account of the smaller space to which it is confined, is twice as great as the depression, because the contents of the spheroid always remain the same. If the waters were capable of assuming the form of equilibrium instantaneously, that is, the form of the spheroid, its summit would always point to the moon notwithstanding the earth's rotation. But on account of their resistance, the rapid motion produced in them by rotation, prevents them from assuming, at every instant, the form which the equilibrium of the forces acting upon them requires. Hence, on account of the inertia of the waters, if the tides be considered relatively to the whole earth, and open sea, there is a meridian about 30° eastward of the moon, where it is always high water both in the hemisphere where the moon is, and in that which is opposite. On the west side of this circle the tide is flowing, on the east it is ebbing, and on every part of the meridian at 90° distant, it is low water. This great wave, which follows all the motions of the moon as far as the rotation of the earth will permit, is modified by the action of the sun, the effects of whose attraction are in every respect like those produced by the moon, though greatly less in degree. Consequently, a similar wave, but much smaller, raised by the sun, tends to follow his motions, which at times combines with the lunar wave, and at others opposes it, according to the relative positions of the two luminaries; but as the lunar wave is only modified a little by the solar, the tides must necessarily happen twice in a day, since the rotation of the earth brings the same point twice under the meridian of the moon in that time, once under the superior, and once under the inferior, meridian.

In the semidiurnal tides there are two phenomena particularly to be distinguished, one occurring twice in a month, and the other twice in a year.

The first phenomenon is, that the tides are much increased in the syzigies, or at the time of new and full moon. In both cases the sun and moon are in the same meridian; for when the moon is new, they are in conjunction, and when she is full, they are in opposition. In each of these positions, their action is combined to produce the highest or spring tides under that meridian, and the lowest in those points that are 90° distant. It is observed that the higher the sea rises in full tide, the lower it is in the ebb. The neap tides take place when the moon is in quadrature; they neither rise so high nor sink so low as the spring tides. The spring tides are much increased when the moon is in perigee, because she is then nearest to the earth. It is evident that the spring tides must happen twice in a month, since in that time the moon is once new and once full.

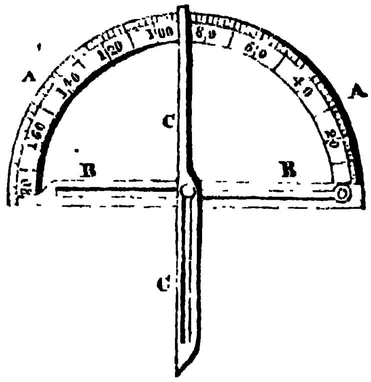
The second phenomenon in the tides is the augmentation, which occurs at the time of the equinoxes, when the sun's declination is zero, which happens twice every year. The greatest tides take place when a full or new moon happens near the equinoxes while the moon is in perigee. The inclination of the moon's orbit to the ecliptic is 5° 8′ 47″·9; hence, in the equinoxes, the action of the moon would be increased if her node were to coincide with her perigree. For it is clear, that the action of the sun and moon on the ocean is most direct and intense when they are in the plane of the equator, and in the same meridian, and when the moon in conjunction or opposition is at her least distance from the earth. The spring tides which happen under all these favourable circumstances must be greatest possible. The equinoctial gales often raise them to a great height. Besides these remarkable variations, there are others arising from the declination or angular distance of the sun and moon from the plane of the equator, which have a great influence on the ebb and flow of the waters. The sun and moon are continually making the circuit of the heavens at different distances from the plane of the equator, on account of the obliquity of the ecliptic, and the inclination of the lunar orbit. The moon takes about twenty-nine days and a half to vary through all her declinations, which sometimes extend 28¾ degrees on each side of the equator, while the sun requires nearly 365¼ days to accomplish his motion from tropic to tropic through about 23½ degrees; so that their combined motion causes great irregularities, and, at times, their attractive forces counteract each other's effects to a certain extent; but, on an average, the mean monthly range of the moon's declination is nearly the same as the annual range of the declination of the sun: consequently, the highest tides take place within the tropics, and the lowest towards the poles.

Both the height and time of high water are thus perpetually changing; therefore, in solving the problem, it is required to determine the heights to which the tides rise, the times at which they happen, and the daily variations. Theory and observation show, that each partial tide increases as the cube of the apparent diameter, or of the parallax of the body which produces it, and that it diminishes as the square of the cosine of the declination of that body. For the greater the apparent diameter, the nearer the body, and the more intense its action on the sea; but the greater the declination, the less the action, because it is less direct.

(To be continued.)

THE GONIOMETER.

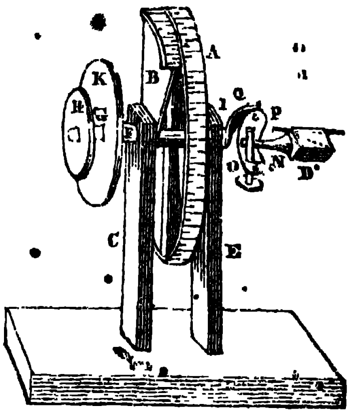
The instruments which are used for measuring the angles of crystals are termed *goniometers*. The simplest of these consists of a protractor or semicircular scale of degrees, A A, and a small pair of compasses or nippers, B B, C C, destined to receive the crystal.



The centre of the pair of compasses is made moveable, like those of the common proportional compasses, so as to permit the legs B B, and C C, to be considerably lengthened or shortened, when the two pieces are applied to each other. The fixed leg B B, is represented as beneath the moveable one C C, or radius, measuring 90°, and the lower end of the centre-pin, which could not be shown in the wood-cut, is made to fit the hole or centre in the protractor precisely at the same time that a stud or projecting piece of brass, being admitted into the long perforation of the leg B B, the piece becomes steadily attached to the protractor or semicircle, as is seen in the figure.

The application of this instrument is obvious.—The crystal to be measured is applied between the compasses, which being thus set, are applied to the protractor, and the value of the angle may be read off at the edge of the leg C C. It is, however, seldom that accurate results can thus be attained, for the surfaces of crystals are generally too small or too imperfect to admit of such method of measurement.

The *reflective goniometer*, invented by Dr. Wollaston, is a more useful and perfect instrument. It enables us to determine the angles even of minute crystals with great accuracy; a ray of light reflected from the surface of the crystal being employed as radius, instead of the surface itself. Mr. W. Phillips has given the following description and practical details for the use of this instrument, in his "Introduction to Mineralogy."



A is the principal circle, graduated on one edge to half degrees, and divided, for convenience, into two parts of 180° each. B is a brass plate, screwed upon, and supported by, the pillar C, and graduated as a vernier. F is the axle of the circle A, and passes through the upper part of the two pillars C E, the other ends of which are inserted into a wooden base. G is an axle, enclosed within F, and turned by means of the smallest circle H, which communicates a motion to all the apparatus on the left of I, without moving the principal circle A.—K is a circle, to which is attached the axle of the principal circle. If, therefore, we would move the latter, it will be done by moving K; and as the axle of the principal circle includes that of the apparatus on the left of I, we necessarily give a motion to the whole instrument by moving the circle K.

These two movements being understood, let us now suppose that we want to measure a crystal; a rhomboid of carbonate of lime, for instance. Let D be the rhomboid, attached by means of wax to one end of a plate of brass N, the other end of the plate being placed in a slit in the upper part of the circular brass stem O, which passes through the tube, to which it is so adjusted as to allow of being moved either up or down, or circularly, by means of the nut. The tube is fixed to the curved brass plate P, which is attached, but so as to allow of motion, to another curved plate Q, by means of a pin, the other end of the latter plate being connected with the concealed axle G, to which a motion is given by turning the little circle H. By means of the pin and the tube, therefore, we have two motions, in addition to the two before described as belonging to the axles of the instrument. The inner axle, however, may be said to be the centre of all the motions. It will, therefore, be of advantage that the rhomboid of carbonate of lime should be placed as nearly *on a line with that axle* as possible; this will be sufficiently adjusted by means of the stem O, which admits of being raised or depressed at pleasure.

The use of this instrument depends on the reflecting power of the polish on the natural planes, or fractured surfaces of minerals; and that this is in some cases very powerful, any one may convince himself by looking upon a very brilliant plane, held beneath the eye, with its edge nearly touching the lower lid, and not far distant from a window; he will then observe the reflection of the bars very distinctly. Let us then suppose the goniometer, as above represented, to be distant from a window from eight to twenty feet. Let there be, then, a *black line* (the use of this is essential) drawn on the wainscot between the window and the floor, and *perfectly parallel* with the horizontal bars of the window. If, then, the eye be placed almost close to the rhomboid or crystal, a reflection of one of the bars will be seen on one of its planes. Let us suppose the reflection to be in the direction of the lower dotted line on the plane; and it will be clear that it cannot be parallel with the bar of the window, not being even with the black line. If, however, the reflection appears to be like the upper dotted line, that is, parallel with the black line, we must first convince ourselves that it is so, simply by depressing the crystal a little, by means of moving the little circle H, so as to bring the reflection upon *the black line.* This being adjusted, which must be done precisely, we then turn the crystal, by turning the little circle H, until the reflection of the *same bar* be seen on the next plane, perfectly *on a line with and upon the black line.* However, in adjusting the second, we may disturb the first reflection. By perseverance it will be found that both can be adjusted by means of one or the other of the movements, or by the help of both, and a short experience will do away the chief difficulties. Both reflections being precise, we are now, by means of the circle K, to turn the principal circle until it is arrested by a stop on the pillar C; it will then be found that 180 on the principal circle coincides with cipher on the vernier. In doing this, however, we may slightly disarrange the reflections on the plane of crystal, which may be re-adjusted simply by moving the little circle I, which will not disturb the principal circle A; we must be certain, however, *that* 180 *on it forms a line with cipher on the vernier, at the same time that the reflection of the bar is seen along the black line.* One movement more, and the measurement will have been made. Turn the circle K, keeping the eye almost close to the rhomboid, until the reflection of the *same bar* is seen on the adjoining plane *precisely upon the black line* on the wainscot, and the operation is completed. It must then be observed what proportion of the principal circle has been moved. Suppose that 105° on it, be now on a line with cipher on the vernier;—it is the value of the angle. But suppose it to be a little more than 105, and less than 105½;—it must then be observed *which line of the vernier touches, or forms but one line with,* another line on the principal circle; suppose it to be 5 on the vernier, the angle is then 105° 5′, which is the true value of the obtuse angle of a rhomboid of carbonate of lime.

POLARIZATION OF LIGHT.

THE following valuable paper on the polarization of light is by Mr. Goddard, the inventor of a polariscope and other apparatus on this subject.

The beautiful phenomena of colors produced by the transmission of polarized light through doubly refracting crystals, the various bands and concentric rings, composed of all the most brilliant and delicate tints of the solar spectrum, and the different forms, changes, and modifications, that they may be made to undergo and exhibit, are so numerous and varied as to furnish a display of the most splendid experiments within the whole range of science; whilst their value and importance in the sciences of mineralogy and chemistry, from the deep insight which polarized light affords of the minute structure and constitution of transparent bodies, which appear, upon every other mode of examination, to be perfectly homogeneous, yet, when viewed in polarized light, exhibit the most exquisite structure, (as is seen in the extraordinary configurations of apophyllite, analcine, and many others, displaying the influence of laws of combination, of which it is impossible, by any other means, to obtain the least knowledge,) renders an exhibition of these experiments not only interesting, but most desirable and important. For this purpose, after having tried numerous experiments upon the different methods now in use, I have constructed a polariscope, adapted to Mr. Cary's hydro-oxygen microscope, which is capable of exhibiting, upon a disc, on a highly magnified scale, all the beautiful and curious phenomena of this interesting branch of science.

But, previous to describing the polarizing apparatus, and the effects that may be produced by means of it, it may be as well to give a short and popular explanation of what polarized light is; and, to do this, we must notice the principal hypothesis upon which the Huygenian or undulatory theory of light is founded, at least so far as relates to the phenomena under consideration: but in so doing, I beg that I may not be understood as advocating this theory in opposition to any other, but merely using it as affording a popular explanation, which those who give a preference to its rival will have no difficulty in understanding, and can, if they please, substitute the language of its rival, the corpuscular theory.

The following are the principal postulata, according to Sir W. J. Herschel, upon which this, the undulatory theory, is founded.

1. It is supposed that a rare, elastic, and imponderable medium, or ether, fills all space, and pervades all material bodies, occupying the intervals between their molecules, and possessing inertia, but not gravity.

2. That the molecules of ether are susceptible of being set in motion by the motions of particles of ponderable matter, which motion it communicates in a similar manner to adjacent molecules; thus propagating it, in all directions, according to the same mechanical laws which regulate the propagation of undulations in other elastic media, as air and water, according to their respective constitutions.

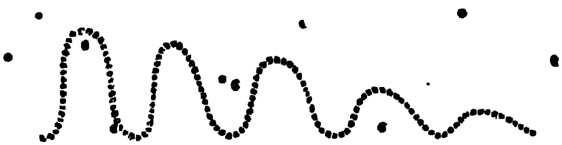
3. That vibrations communicated to the ether, in free space, are propagated, through refractive media, by means of the ether in their interior, but with a velocity decreasing with its inferior degree of elasticity.

4. That when regular vibratory motions, of a

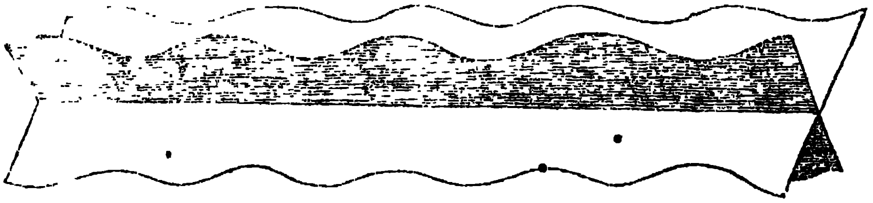
proper kind, are propagated through the ethereal media, and pass into our eyes, and reach and agitate the nerves of the retina, they produce in us the sensation of light, in a manner more or less analogous to that in which the vibrations of the air affect our auditory nerves in producing sound.

5. That as, in sound, the frequency of the aerial vibrations, or number of excursions of each molecule of air, determines the note, so, in light, the frequency of the vibrations made on our nerves, in a given time, by the ethereal molecule, determines the color of the light: and that, as the extent of the vibrations of air determines the loudness of the sound, so the extent of the vibrations of the ethereal molecule determines the intensity of light.

To understand how waves are produced, by the vibrations of the particles of an elastic medium, we have only to study the waves produced upon the surface of a pond of water when rain is falling; it will be found that the particles of water driven down by a single drop of rain force the adjacent ones upwards, the air above, in consequence of its being more elastic, yielding sooner to the pressure exerted by the displaced particles on those surrounding the point of disturbance. Thus a wave is raised round this point by the momentum of the falling drop, and, as soon as such momentum is spent, the effect of gravity draws the raised particles down to the common surface of the liquid; the momentum, however, which they have acquired in this descent, carries them below the level, or point of rest; and, in descending below this point, they cause, among the adjacent particles of still water, a motion similar to that by which they were themselves actuated by the falling drop. The second wave thus produced will, in its descent, cause a third; and thus a series of waves, decreasing in height as they increase in breath, will be produced in rings, vibrating up and down, as is easily proved by placing a cork upon a smooth surface of water and producing a series of waves, when the cork will produce the same vibrations as the particles of water upon which it floats. Such vibrations present the appearance of waves, as the motion is communicated from one particle to those adjacent, as is represented by Fig. 1, which we may suppose to be a section of the surface of water at the time of the appearance of the waves, the dots being the separate particles.



Dr. Young, in applying the undulatory theory of light to the explanation of the various phenomena, while considering the results of Sir D. Brewster's researches on the laws of double refraction, first proposed the hypothesis of transversal vibrations, which has since been shewn to be a necessary consequence of dynamical principles, and is most important to the explanation of our subject. These vibrations he illustrated by the propagation of undulations along a stretched cord, agitated at one end, which, supposing a person to hold in his hand, and, by moving first quickly up and down, a wave will be produced, which will run along the cord to the other end; and then, by a similar movement, but from the right side to the left, another wave will be produced, which will run along the cord as the former; but the vibrations or undulations of each will be in planes at right angles to each other and independent of each other, one being in a perpendicular plane and the other in a horizontal plane; so that, according to this theory, Fig. 2 may be supposed to represent a a ray of ordinary or unpolarized light. I have chosen this representation of a single ray of ordinary light, which is a drawing of one of Mr. Woodward's beautifully simple card models, as it conveys at once to the mind a distinct notion of the planes in which the vibrations take place. A beam of light we may therefore conceive to consist of a succession of systems of waves following each other with immense rapidity, and comprising an immense number of rays, the vibrations of which are performed in every possible plane.



(*To be continued.*)

ELYDORIC PAINTING.

This method of painting, called elydoric, was invented by M. Vincent, of Montpetit. It takes its name from two Greek words, denoting oil and water, both these liquids being employed in its execution.

Its principal advantages are, that the artist is able to add the freshness of water colors, and the high finishing of miniature to the mellowness of oil painting, in such a manner that the work appears like a large picture seen through a concave lens.

The following is the manner of proceeding:— A piece of very fine linen or white taffety is sized with starch in the most equal manner possible, on pieces of glass about two inches square, in order that the cloth may be without wrinkles. When these are sufficiently dry, a layer of white lead, finely ground in oil of pinks or poppies, (the whitest that can be procured,) is to be applied on them with a pallet knife. To this layer, when dry enough to admit of scraping, more is to be added, if necessary.

As it is of very great importance for the preservation of this kind of painting, that the layers be free from oil, that they may better imbibe the colors laid on them, it is necessary that their surface be made very smooth, and that it be very dry and hard.

The artist is next to procure a circle of copper, about two inches diameter and one-fourth of an inch in height, extremely thin, and painted black on the inside. This circle is to contain the water on the surface of the picture.

Water distilled from rain or snow is preferable to any other; ordinary water, on account of the salts which it contains, being pernicious to this mode of painting.

The colors are to be finely levigated between two oriental agates, carefully preserved from dust, and mixed with oil of poppies, or any other cold siccative oil, which should be as limpid as water.

All the colors being ground, are to be placed in small parcels on a piece of glass, and covered with distilled water.

The materials being thus prepared, the subject to be painted is to be faintly traced with a black-lead pencil on one of the pieces of cloth above-mentioned. The tints are then to be formed on the pallet from the little heaps under the water; and the pallet placed, as usual, in the left hand. The picture is to be held between the thumb and forefinger, supported by the middle finger, and the necessary pencils, the third and little fingers. The hands rest on the back of a chair to give a full liberty of bringing the work nearer to, or removing it far from the eye.

After having made the rough draught with the colors still fresh, the circle of copper, which is to surround the picture, is to be fitted exactly to the surface. Distilled water is then poured within this circle till it rises to the height of one-eighth of an inch, and the eye is held perpendicular over the object. The third finger of the right hand, while painting, should rest on the internal right angle of the picture. The work is then to be re-touched, the artist adding color and softening as he finds requisite. As soon as the oil swims on the top the water is poured off, and the picture carefully covered with a watch-glass, and dried in a box by a gentle heat. When dry enough, it is to be scraped nearly smooth with a knife, the artist repeating the former method till he is satisfied with his work.

It is at this period that the advantage of this new method particularly shows itself for the purpose of finishing; as the water poured on the picture discovers every fault of the pencil, and gives the power of correcting and perfecting it with certainty.

When the work is finished it is put under a fine glass, from which the external air is excluded, and then it is dried by means of a gentle heat.

ELECTRICITY OF STEAM.

To the Editor.

Sir.—I take the opportunity of mentioning, in reference to the subject of the electricity of steam, a circumstance which occurred to myself some time ago. I was making an experiment, in which I was collecting, in a gas-holder, the gas and steam which were thrown off from two retorts containing respectively tar and water. I was very much surprised to observe, shortly after the commencement of my experiment, the discharge of at least two elective sparks from the top of the glass tube which is used for ascertaining the quantity of gas by the quantity of water contained in the vessel. My attention at the moment being otherwise occupied, I gave little heed to the circumstance, thinking it probable that this manifestation of electricity was owing to some peculiar chemical action resulting from the union of the gases. The accidental discovery of electrical phenomena in steam generated under high pressure, inclines me to think otherwise now. You will be much the best judge whether the publication of this circumstance will assist, though ever so feebly, in the elucidation of the subject. S. M. TAYLOR.

Orford Place, Chelsea.

ON MANAGING BALLOONS.

To the Editor.

Sir.—A suggestion having occurred to me to render balloons more manageable, I beg to submit it to your scientific readers. It consists in having a fire in the car, and a tube (open at the top) from the fire or stove to pass through the balloon, (from the bottom through the top,) but not so as to touch the gas, the hole through which the tube passes being intended to be closed up with cloth, so that if the tube were removed, it would have no aperture for the gas to escape, as the cloth tube would be left in the cavity. This tube must have a valve in it near the bottom which can shut or open the passage at pleasure; and it is by means of hot steam or heat passed through it that the balloon is to be caused to ascend and descend. When wished, then, for it to ascend, the valve must be caused to open the passage, when the heat passing through the balloon will dilate the gas, and the balloon will consequently rise. For descent, then, the valve must be closed. But the balloon must not be nearly full, otherwise it could not expand, but must burst. No ballast will, it is presumed, be required, and probably some progression might also thereby be obtained, by employing a sort of nearly horizontal sail and inclining it one way or the other, as the balloon ascends; and the resistance of the air would then, it appears, cause the ballooon to progress. Suppose, then, the aeronaut wished to go eastward, he must let a current of hot air pass through the balloon, and at the same time incline the east end of his sail upward, and then close the passage so as to let the gas cool (or, if any method should occur, he may send in some cold air,) and as the balloon would thereby descend, he must turn the east end of the sail downward, and the balloon would go in the contrary way.

But the car ought to be fire-proof. It does not seem impossible to produce the same effect without fire by means of an apparatus in the car to condense and exhaust the gas; but then the tube must, instead of passing through the balloon, open into the balloon itself, and this method would be very laborious.

But with respect to ballast, I am obliged to confess my ignorance why any is ever required, as it seems that the only reason why it is adopted is because too much gas is put in the balloon, which, if not full, must expand as it rises into a more rarefied atmosphere, as, the more the outside air be rarefied, the more so will be the gas within; and, if the balloon be full before it rises, it cannot expand, but may burst.

The machine lately exhibited at the Polytechnic Institution of a cross sail applied to a balloon, seems to be the same as was invented by me, and also by another person, signed "Volitor," several years ago, and, which, on being turned round, rose in the air. (See the *Philosophical Magazine for* 1814, and the *Mechanics' Journal, &c.*)

L. GOMPERTZ.

Oval, Kensington.

To form Figures in Relief on an Egg.—Design on the shell any figure or ornament you please, with melted tallow or any other fat oily substance; then immerse the egg in very strong vinegar, and let it remain till the acid has corroded that part of the shell which is not covered with the greasy matter: those parts will then appear in relief, exactly as you have drawn them.

MEDICAL RECEIPTS.

SNUFFS.

The base of all snuffs is, or ought, to be, ground tobacco, the part of the plant used being the stalks of the plant. The following are general directions on the manufacture of it:—

Perfumed Snuffs.—The tobacco being ground and sifted, as the scented snuffs do not require much pungency, it may be mixed with mahogany sawdust, or that from rose-wood, or else the pure tobacco powder may be soaked in water, (the water being serviceable to steep cabbage and lettuce leaves in to make "penny Havannahs;") then pressed nearly dry, then dried, afterwards moistened with rose-water, or orange flower water; and finally sufficiently dried for sale—a little oil of tartar being put into all the moist snuffs to keep them damp at all times. French snuff is scented with the root of calamus aromaticus.

Macouba Snuff owes its flavor, and perhaps its sedative powers, to the previous fermentation of the tobacco leaves by moistening them with cane juice, and probably producing in this way an acetate of the narcotic principle of the tobacco, if such exist, as there is reason to believe there does?

Lundyfoot's Snuff, which has a burnt odour, somewhat like malt, is prepared by partially torrifying the materials, and is imitated by moistening any light colored snuff with empyreumatic oil.

Eye Snuff.—Triturate and mix together, in a marble mortar, 5 grains of sulphate of mercury with 2 scruples of liquorice root, powdered. Grimstone and others disguise this by various ingredients. It is a powerful errhine in producing a discharge from the nose, when snuffed up in small pinches, but it is not safe.

Cephalic Snuff.—The following are various receipts recommended for this snuff:—Mix together equal parts of the leaves of asarabacca, marjorum, and of the lily of the valley, dried leaves of asarabacca 1 ounce, flowers of lavender 2 drams, dried leaves of asarabacca 3 ounces, leaves of the dock and flowers of lavender each 1 ounce, sage leaves, rosemary, lilies of the valley and the tops of sweet marjorum, of each 1 ounce, with a dram each of asarabacca root, lavender flowers and nutmeg; pound and sift it very finely.

Yellow Snuff.—Yellow ochre the size of an egg, add chalk to lower the color, grind with half an ounce of oil of almonds till fine, then add water by degrees, and two spoonsful of the mucilage of gum tragacanth till you have about a quart, mix this with purified snuff and dry it; then sift it through a very fine sieve to remove the color which does not adhere to the snuff, and moisten it afterwards with any scented water that may be desirable.

Tabac (Snuff) Perfumè aux Fleurs.—Put orange flowers, jasmine, common or musk roses, or tube-roses with the snuff for a day and a night, and sift them out; repeat this as often as necessary. Snuff does not heat with the flowers. Snuffs are also scented with musk, civette, ambergris, the essence of bergamot, rose-water, elder-flower water, &c.

KINDS OF CAMPHOR.

Rough Camphor, Laurel Camphor, Camphora.—Obtained from the roots and shoots of the Laurus camphora, L. cinnamomum, and Capura curundu, by distillation with water. Comes from China and Japan.

Dryobalanus Camphor.—Very little of this camphor comes to Europe, it being carried to China, where it sells for about thirty times the price of their own laurel camphor. Obtained by merely splitting the Dryobalanus camphora; the heart of this tree containing camphor mixed with oil of camphor. It comes from Sumatra and Borneo.

Refined Camphor, obtained by sublimation with one-sixteenth its weight of lime in a very gentle heat. Camphor is stimulant, narcotic, and diaphoretic, in doses of 5 grains to 1 scruple, in pills or a bolus: too large a dose occasions vomiting and convulsions; its effects are counteracted by opium; it may be suspended in liquids, by means of mucilage, yolk of egg, or almonds. Camphor is put into boxes to keep insects from them, and is used in fireworks; it renders copal soluble in some essential oils.

Liquid Camphor, Oil of Camphor, Camphora liquida, Oleum camphoræ. — From Dryobalanus camphora, by piercing the tree.

Rosemary Camphor.—Obtained from the oil by a careful redistillation, without addition, of one-third of the oil; the residuum affords crystals of camphor; on separating which, and re-distilling the remaining oil two or three times, the whole of the camphor, amounting to 1 oz. from 10 of the oil, may be obtained.

Sweet Marjorum Camphor.—Obtained in like manner, about 1 oz. from 10 of the oil; not volatile; when set on fire, it soon goes out.—*Saye Camphor*, 1 oz. from 8.

Lavender Camphor, 1 oz. from 4, or even less, of oil.

Thyme Camphor.—Crystals cubical, does not form a liquid solution either with nitric or sulphuric acid; is precipitated from nitric acid in a glutinous mass.

Soap Camphor.—Obtained from soaps, by solution in water, adding muriatic acid, collecting the curd, washing it with boiling water, and pressing it to separate the liquid elaine. It is a mixture of stearic and margaric acids; used to make candles, which are very white, as neat as wax candles, and give a brighter light, but do not last so long.

Turpentine Camphor.—Obtained from spirit of turpentine, by passing muriatic gas through it, by which means it will yield about its own weight of a kind of artificial camphor, not dissolved by dilute nitric acid, and when dissolved by strong nitric acid not separated by the addition of water.

Citron Camphor.—Obtained from the white rectified oil of citrons, exposed to muriatic acid gas it absolves 286 times its bulk, or nearly half its weight, and yields about 9-10ths of camphor.

It will be seen immediately that these two last are muriates; the first, or that from turpentine, is the muriate of camphogen, or artificial camphor; camphogen being the supposed base of turpentine, while the citron camphor is the muriate of citrene; citrene being the new name of the oil of lemons.

Common Camphor is called the protoxyde of camphogen, and consists of carbon 10 parts, hydrogen 8 parts, and oxygen 1 part; by distilling it with nitric acid it absorbs 4 parts more of oxygen, and becomes camphoric acid.

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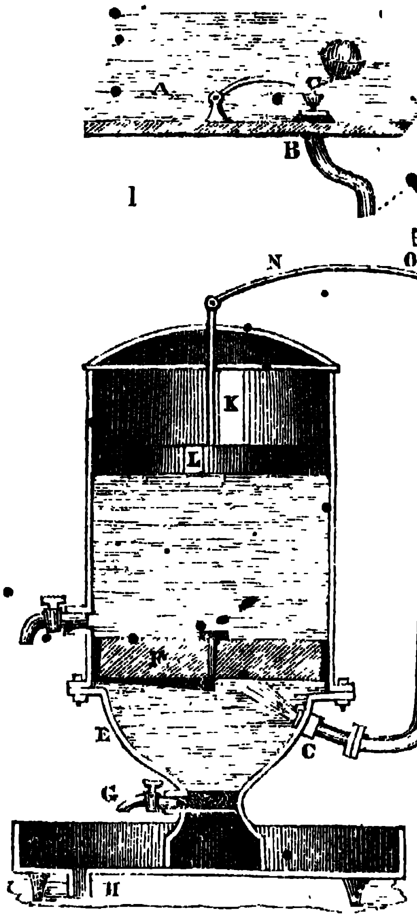
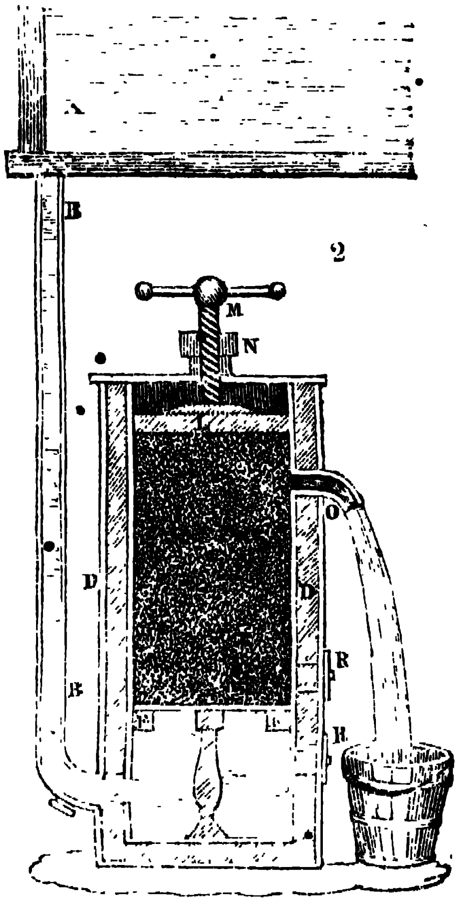
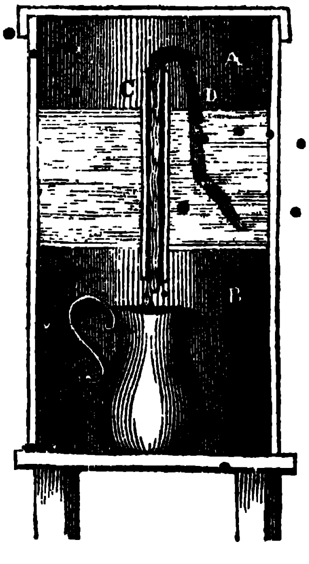
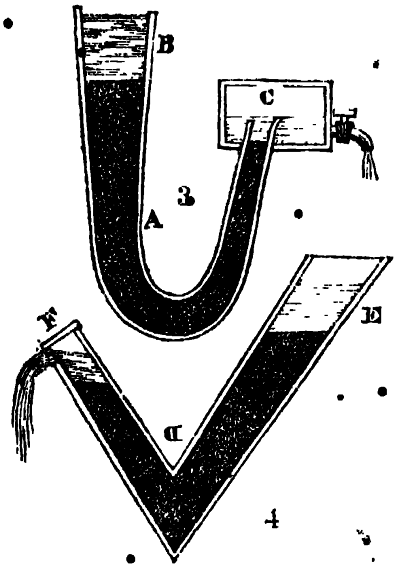
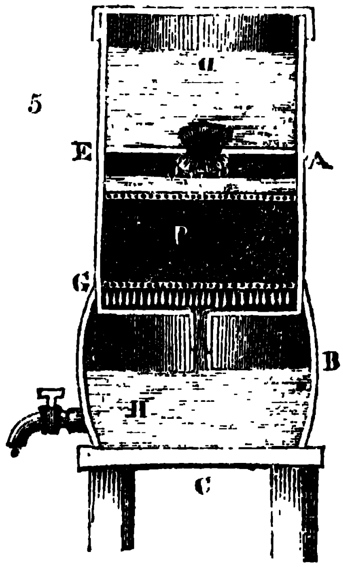




FILTERING MACHINES FOR WATER.







FILTERING MACHINES FOR WATER.

THE approach of summer, and the vast amount of animal and vegetable life which it gives rise to, contaminating so much the water of ponds and streams, induce us to offer this week a few remarks on *filtering*, with the view of directing our readers to a knowledge of the construction of some simple filtering machines.

The first of these machines which we shall notice is Messrs. White and Aveline's "artificial spring," in which the water is made to filtrate upwards by its pressure against the under side of a stone, the quantity filtered depending upon the area of the stone, and the height of the reservoir from which the water descends; but with a head of 35 feet, which can be obtained in most houses in London, a stone of 10 inches square will filter nearly 30 gallons per hour. The engraving, Fig. 1, exhibits a vertical section of the apparatus. A is the cistern which receives the water in its impure state; it has a ball float and lever to keep a constant head of water over the pipe B, and likewise to prevent any air passing down it. The pipe B is shown broken off, that the space between may be considered as of any required length. To the lower end of the pipe there is a nozzle C through which the pipe passes, which causes the water to shoot up against the under surface of the filtering stone F. Through this stone the water oozes with great rapidity, leaving the animalculæ and other impurities in the lower part or basin E of the machine, from whence they are drawn off occasionally by the cock G, and carried away by the waste-pipe H. When the filtered water rises in the reservoir above K, to a certain height, the filtration is stopped by the rising of the float L, which by its lever or rod N, shuts a cock O in the supply pipe. When the stone has become charged with a deposit on its under surface, it is capable of being cleansed by the scraper S, which is turned round by means of a handle shown at the bottom of the reservoir K, the axis passing through the stone; provision is thus made for reviving the filtering properties of the stone whenever required, and with very little trouble.

A very old contrivance for filtering water, but which has been the origin of most of the more recent apparatus for the purpose, consists in nearly filling the two legs of a pipe, formed either of metal as in Fig. 3, or of wood as in Fig. 4, with washed sand, leaving merely a space at B and E to receive the turbid water, and another at C or F for the filtered water to run off by. The chief objection to these machines is, that they soon become foul, and consequently useless, until restored by cleansing, and this task, as generally performed, is such a laborious, tedious, and slopping one, that these filters are usually abandoned in a short time.

The engraving, Fig. 5, represents an apparatus of a convenient form, by Mr. James, of Knightsbridge. It consists of two vessels, A and B, of stone-ware, placed upon a strong stand C. The upper vessel, which is covered, receives the impure water in a chamber D, at the lower part of which there is a large aperture, stopped by a sponge E, which detains the grosser impurities: hence the water passes through a finely-perforated earthenware plate into a layer of six inches of prepared charcoal, through which the water filters, and is thereby purified from any noxious smells, as well as any floating impurities; it then passes through another perforated plate G, and is received at H into the separate vessel, which is a stone-ware cask, from which it may be drawn off at pleasure by the cock.

A very simple method of freeing water from its impurities by means of the capillary attraction of fibrous substances is represented in the annexed engraving. A is the reservoir. B the lower compartment. C an open tube soldered into the bottom of the reservoir, in which is put a wick of cotton or wool, (the latter is best,) with one end immersed in the bottom of the reservoir, whilst the other end hangs down a little below it, forming a kind of syphon. The water in rising by the capillary attraction between the filaments, deposits the gross matter floating therein, and descends in a comparatively pure state into the vessel B, or into a jug.

The engraving, Fig. 2, represents an apparatus contrived by Messrs. Williams and Doyle, for the purpose of separating the salt from sea-water, by merely causing it to percolate through a body of sand under mechanical compression, and thus to render it fresh. Could this object be obtained by such means, the invention would doubtless be one of the utmost importance to navigation, as it would render a store of fresh water unnecessary, thereby affording additional stowage for provisions or cargo; but we are not aware of any experiments proving that substances dissolved, and chemically combined with a liquid, can be separated by filtration; we therefore apprehend that the apparatus would be ineffectual for the object the inventors had in view, although it may prove very efficient in freeing water from any impurities floating or suspended in it. The following description of the engraving (which represents one of the several modes of construction proposed by the inventors,) is derived from the specification of their patent. A is a part of the cask supposed to contain sea-water. B a tube descending therefrom, made fast by bands to the filtering apparatus D D, which is a strong square trunk of wood, lined internally with sheets of lead, which are cemented together to prevent the interposition of water. This part of the apparatus is given in section, that the construction and arrangement may be seen at one view. E is the lower chamber, where the water is first received. F is a strong stool of open frame-work, supported on five stout legs F F. Over this short frame is nailed a plate of copper, pierced with numerous small holes. Over the perforated plate are several layers of woollen cloth, or woven horse-hair, and above these a body of sand, filling up the entire trunk. On the top is placed a sliding cover L, which is operated upon by a strong screw M, working through a fixed nut N, which is supported by curved iron arms, extending from opposite sides of the trunk. The sand having been compressed, by the agency of the screw, into a more dense and compact mass, is prevented from rising by the pressure of the water, which percolating through the minute interstices to regain its level, deposits its salt, and runs out by the pipe O in a fresh state into a vessel P placed to receive it. When the sand has become saturated with salt, it is to be removed by taking out the screw and the pressing-board L; the man holes R R may then be opened by unscrewing the plugs, when the other materials may be easily sifted. These matters being completed, a fresh quantity of sand may be taken from the ballast of the ship, and the process of filtration continued as before.

OBTAINING STEEL OF DIFFERENT COMPOSITIONS AND QUALITIES.

In a memoir on the manufacture of cast steel at St. Zlataoust, the imperial manufactory of swords and of iron, situated in the southern part of the Oural mountains, Colonel Anosof describes the processes adopted in that manufactory to produce the steel in earthen crucibles by the fusion of bars of iron and steel by means of blast furnaces. The peculiarity of this process consists in this; that iron is put into the crucibles covered with charcoal to submit it to a kind of cementation, whilst in England steel previously cemented is employed. In other respects there is nothing new in the method adopted, but it may be serviceable to state, briefly, the means indicated by the author of the memoir of obtaining steel of different varieties in its composition and qualities. The following are his observations on this point:—

"The processes adopted for the fabrication of steel are sufficient to show the principal causes which tend to vary the qualities of this metal; as, for example, the quantity of carbon absorbed by the iron and the nature of the iron itself. As the first of these causes may be regulated at will, it requires no explanati[illegible] and the second need not now be considered, [illegible] will therefore confine myself to the rules that I have formed, which are the results of a great number of experiments.

"1st. The purer the iron, that is, the more free it is from other substances, the better will be the steel procured from it; but the cementation will require longer time.

"2d. All qualities of soft iron are not to be preferred to brittle iron; for if the hardness of the latter be caused by the carbon it contains, it is preferable to soft iron, of the same qualities in other respects.

"3. The aptitude of the iron to be converted into steel depends more on the quality of the iron ores even than on the preparation of the iron. For instance, the iron procured at Zlataoust, from the ore extracted from the Tesminck mine, is preferred to that of all the other mines in that neighbourhood; and the iron from the iron works of Tugilsk produces steel of a superior quality to that from Zlataoust.

"4th. The steel clippings from the swords made with cemented steel produce cast steel of a quality little superior to that of the clippings of iron.

"5th. The bars of iron which have been buried underground for some time produce steel of a quality superior to that obtained from iron which has been recently manufactured. This fact was known in Asia in the most ancient time, but Europeans having forgotton the lessons of their masters in metallurgy have been in arrear of those nations, not only in the art of making the best steel, but also in the knowledge of the signs by which the perfect article can be positively ascertained. If we are well informed, one English cutler at least, Mr. Weiss, has satisfied himself of the superiority for making steel of iron which has remained a long time under water.

"6th. The clippings or pieces of iron which have been a long time exposed to the air produce worse steel than fresh iron.

"7th. The steel is of better quality when the pieces of iron are homogeneous and of equal size.

"8th. The steel is softer when the opening in the crucible for the proof is small, provided that the pressure of the iron be equal up to the time the lid is put on the crucible.

"9th. If the workman have neglected to put the lid on in time, he may render the steel of good quality by adding as much iron as is necessary to raise the metal to the proper height.

"10th. If at the time of the final proof the steel does not send forth sparks sufficiently bright, the evil indicated by this bad sign may be remedied by introducing through the opening of the crucible two or three pieces of iron of the weight of about half a kilogramme.

"11th. The fusion of the steel mixed with powdered charcoal or soot in determined proportions, and in a closed crucible, as proposed Messrs. Mushet and Bréan, might, indeed, produce steel, but its degree of hardness would be much less certain than on the plan I have described. In fact, if the charcoal be in excess the steel will become too hard; if there be not enough, the metal will be difficult to fuse, because a part of the charcoal will be volatilised.

"12th. The addition of other metals, such as platinum, silver, or gold, in the proportions of 1·5 to 1·2 per cent., somewhat improves the quality of the steel, but the more pure the steel is, the less advantageous do such additions become. The effect of the addition of these metals consists principally in making the steel more easily forged, the proportions of carbon and iron being equal.

"As to brittle metals, their mixture with steel is always more or less injurious, and this becomes more apparent in proportion as the quantity of the alloy is increased."—*Moniteur Industriel.*

BOTANICAL NOTICES.

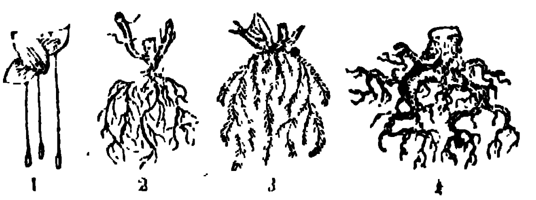
ROOTS.

The root is that part of a plant which grows away from the light. Its use is to absorb moisture for the support of the rest of the plant, and generally to fix it to whatever it grows upon.

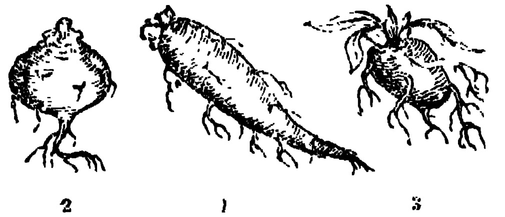
The root is called *terrestrial*, if growing in the earth, as the generality of roots do; *parasitic* if attached to other plants; thus the misletoe grows upon the thorn without contact with the soil; *aquatic* if suspended in water, as in the duckweed and numerous other water plants: this kind of root does not fix the plant to any particular spot, not being itself attached to an immoveable substance.

Roots differ from stems in not bearing regular buds upon them, and in growing downwards. they consist sometimes of fibres only—at others of variously-shaped fleshy portions, called the body of the root. This latter part is intended as a storehouse of food, and to equalize the supply to the stem, when the other parts are impeded in their formation and regular action by drought. The fibres are, however, most essential, and alone can be considered the true root, as it is by means of them only that moisture is drawn from the earth and conveyed upwards. Their curious and beautiful structure is apparent in the first germination of a seed, in a vigorous and young root when removed from the earth, and in the fibres of a hyacinth growing in water. In each of these cases the end of every fibre will be found to terminate in a delicate, white, and spongy point, called a spongiole, and which is more than any other part capable of rapid absorption. Owing to its extremely tender nature it is not adapted to long-continued action. The spongioles, therefore, and often the fibres which bear them, die away at the close of each growing season, being replaced by fresh ones when the plants revive.

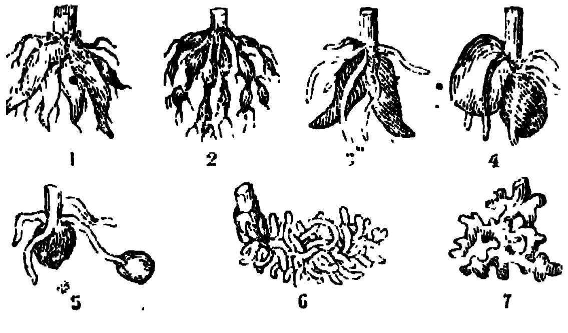
The *fibrous* root is of three varieties. In the first it consists of simple unbranched fibres. In the duckweed it is fine like a thread, (1,)—in the hyacinth and the orchises like strings—and in the screw pine so thick as to resemble stout and strong poles, sometimes two inches in diameter. In the second variety, the fibres are more or less branched, (2,) as we see in ordinary plants. In the third case, the fibres are thickly clothed with long down, (3,) so as to present a shaggy appearance—this is observed particularly in those grasses and sedges which grow upon a sandy shore. The fourth variety exists in trees, where year after year the fibres become changed into a woody substance, increasing, spreading, and strengthening; until at length they form a mass underground, similar to the stem and branches above, not merely in appearance, but general structure, (4.)



The *tap* or *fusiform* root; a fleshy root, thick at top and with the lower part gradually tapering downwards; it is attended with but few fibres, and these are short and branched. Carrots, (1,) parsnips, and radishes, are examples of tap-rooted plants. In the turnip, (2,) it takes a rounder form. If the root perish at the lower extremity, so as to end abruptly, it is called a *premorse* or bitten root (3.) The plaintain and the devil's bit, (scabiosa succisa,) are of this kind.

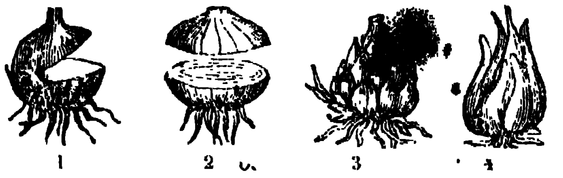


The *knotted* or *tuberculated* root is extremely varied. In the dahlia it consists of a number of fleshy tapering bodies united together, (1.) In the dropwort the fibres of the root are loaded with spindle-shaped knots, (2.) The roots of some of the orchis tribe consist of two finger-like portions, (2,) or else of two solid bulbs, (4,) one of which dies away each year, while a new one is being formed: in a few these bulbs are at a distance from each other, (5.) In the bird's-nest orchis the root consists of a mass of fibres, interlacing each other, (6,) and in the coral root, (corallorhiza innata,) it resembles the branching of a piece of coralline, (7.)

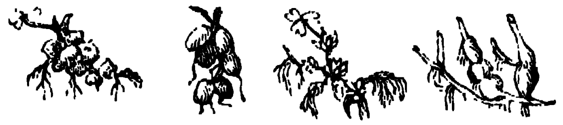


The above are truly roots. The following are in reality under-ground stems, but as they have until lately been considered roots by botanists, and are still called such by other persons, they may be here classed.

The *bulbous* root is a root to which a bulb is attached: it is divided into the *solid bulb*, as is seen in the crocus, (1)—this is often called *a cormus*. The *coated* bulb, as in the onion, (2.) The *scaly* bulb, which consists of a number of thick leaves folding over each other, as is well known to be the case with the white and the yellow lily, (3.) An aggregate bulb consists of a number of bulbs united together, as in the garlic (4)—each of these separately is called *a clove*. Roots of this description are in their nature correspondent to the leaf and flower buds. They bear from their centre upwards mostly a single unbranched flower stalk and radical leaves, with numerous simple fibres from the lower part. Also during the progress of their growth small bulbs grow around the lower end of the larger one; these are called *off-sets*, and being separated grow into other plants, exactly similar even in all their shades and stripes of color to the original. It is by means of these that tulips, crocuses, hyacinths, &c. are propagated.



The *granular* root is one in which the main fibres of the root are attended with a number of small grains like bulbs. In the white meadow saxifrage, (1,) they are brown and shaped like an onion. In the pilewort, (2,) like grains of wheat both in color and form; and in the wood sorrel, (3,) reddish green, and formed of fleshy scales folding over each other. The root of various grasses is knotted like a necklace, (4)—this form, however, is not constant, but is the result chiefly of want of sufficient moisture.

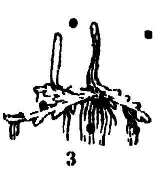


The *tuberous* root is one which has fleshy tubers attached to it. These tubers remain perfect after the root or stem which bears them has decayed, and being furnished with *buds* or *eyes*, as they are called, they are capable of growth; each in the following year producing a plant similar to that which bore them. The potatoe, (figured below,) and the Jerusalem artichoke, are examples.

The *creeping root*, (soboles,) is a thin root which grows horizontally and quickly. It is mostly jointed, throwing out fibres from its various joints downwards, and one or more shoots upwards, whenever it arrives at or approaches the surface. This root is so tenacious of life, that if broken into small pieces each of these will vegetate, producing as many plants; hence the difficulty there is in ex-terminating the couch grass, (1,) the bellbine, and other plants which have a creeping root; hence also the rapid extension and growth of such plants as the asparagus, the mint, (2,) the colt'sfoot, &c. In the dentaria, (3,) the root appears jagged at the edges as if cut into teeth.

1

2



3

The *rootstock* or *rhizoma*—a thick, fleshy, and perennial root, growing occasionally upon, but more frequently just under the surface of the ground—usually decaying at one end as it increases at the other: it is furnished at irregular intervals with buds or crowns, which each year afford fresh leaves, stems, &c. The orris root, the ginger, and the anemone, are examples of the rhizoma.

The peculiar function of roots to supply moisture to the rest of the vegetable, is rendered evident by the endeavour manifested by plants to increase and extend their roots according to their wants—thus such plants as grow in deserts, on dry and hot sand, or on naked rocks, have usually very long and matted fibrous roots, which extend to a considerable depth below the surface, whence more moisture is attainable. Orchideous and other plants often throw out fibres from their stems into the air, as if in search of more food than their other roots can furnish; a plant or tree disturbed from its place of growth, and injured as to the fibres of its roots, will infallibly die, unless it can immediately throw out others; a fact well known to gardeners, who, in transplanting, are obliged to be especially careful that these delicate and essential organs shall be as little as possible disturbed.

HOW TO STUDY CHEMISTRY CHEAPLY,

BY JAMES HERBERT COOKE.

(Resumed from page 21.)

Having described the instrument required by the student, it now remains to give directions for their use, or manipulation, with a few experiments, in order to give an insight into the general management of chemical processes. As these papers are not intended as an introduction to the science, I shall give no further explanation, than will suffice to make the rationale of each experiment well understood; for other information I refer the student to Dr. Reid's "Elements of Chemistry," or to any other lately published work on the subject.

MANIPULATION.

Use of the spirit-lamp, tripod-stand, &c.—The spirit-lamp is used to give heat in evaporation, distillation, preparation of gases, and in all other experiments where a moderate heat is to be applied to small quantities of any substance; also, with the blowpipe, bending and working glass tubes, &c. The flask or evaporating vessel being placed on the tripod, the lamp is adjusted by means of the pieces of wood, to a height beneath it, proportionate to the degree of heat intended to be applied;—when the tin cylinder is employed, care must be taken to leave sufficient space between it and the bottom of the vessel, to allow of a free ascent of the heated air, otherwise the draught will be stopped, and the process much impeded.

Use of flasks, &c.—Flasks are used for distillation, preparation of gases, solution, digestion, &c. For the distillation of water or alcohol, take a clean flask and fit a cork to it, bore a hole through it with a red-hot wire, and enlarge it until it will admit the shorter end of the bent tube, which is passed just through it; four or five ounces of the liquid is then poured into the flask, which is placed on the tripod; the other end of the tube is passed (without a cork) into another flask placed in a vessel of cold water; the liquid in the flask is now made to boil by the application of the lamp, and the steam coming through the tube into the receiver, is there condensed, by the cold water in the vessel in which it is placed; this water should be withdrawn by means of a syphon, when it gets warm, and the vessel refilled with cold water. In distilling acids and other fluids, whose vapours would corrode the cork, make a little plaster of Paris into a stiff paste with water, and apply it to the end of the tube, instead of a cork, fitting it to the neck of the flask as before; the neck of the receiver should also be partially obstructed with tow, as the uncondensed acid fumes are very disagreeable, and even dangerous, if allowed to escape into the apartment.

For the preparation of gases, the bent tube is fitted by a cork, to the flask containing the materials from which the gas is to be extricated, the other end of it being passed under the arch in the shelf of the pneumatic trough, which must be filled with water; the phial intended to receive the gas, being completely filled with water so as to exclude all atmospheric air, close the neck with the finger and invert on the shelf of the trough, over the hole in the bottom of it, the gas then ascends into the bottle, displacing the water; the portion of gas that comes over first should not be collected, as it is always contaminated with atmospheric air; when the phial is full of gas, remove it from the shelf and cork it under water, immediately replacing it with another, previously filled with water; the jar of gas should be preserved until wanted, inverted, with its neck under water, in a wine-glass or gallipot. Gases prepared without heat are collected in the same way; chlorine must be collected over warm water, as it is absorbed in large quantities by cold water. Some gases may also be collected by *displacement*, which consists in conveying the gas, if heavier than air, by a bent tube, to the bottom of the receiver, so that it may gradually drive out the air; if the gas is lighter than air, the receiver must be inverted over the bottle in which the gas is generated, and it is conveyed by a straight tube to the upper part of the receiver; this method may be adopted with those gases that are absorbed or decomposed by water.

Some substances that are insoluble, or nearly so, in cold water, dissolve readily when boiled, or heated in it; sometimes a substance is heated in a liquid for the purpose of extracting some soluble matter from it, which is termed digestion; both these processes are carried on in a flask, with the aid of the tripod and spirit-lamp.

Use of evaporating dishes.—When a substance has been dissolved in a liquid, in order to recover it, we have recourse to evaporation, which is continued, either until crystallization takes place on cooling, or until the substance is left dry in the vessel: for crystallizing, the general rule is, to continue the evaporation until a pellicle or skin forms on the surface of the liquid, when the vessel should be removed and set aside, that crystals may form, which will generally take place in a few hours.

Use of test glasses.—A test is any known chemical body, which, when mixed with an unknown substance, produces appearances, which enables us to judge of its nature and properties: thus, if a solution of ferrocyanate of potass, when added to a mineral water produces a blue color, we know that the water, under examination, contains iron, because a blue compound is always formed when this salt is added to a solution containing iron; the substance formed is termed a precipitate; its form and general appearance are also to be considered, as the color alone is not always sufficient to determine its nature; sometimes a precipitate has to undergo a more particular examination, as to its solubility, &c., in which case, we have recourse to *filtration*, to separate it from the liquid in which it was formed. Wine-glasses, &c. used for testing, or precipitation, should be quite plain and free from cutting and ornament.

Filtration.—In order to collect a precipitate, to free a liquid from dirt or impunity, it must be made to pass through a filter of porous paper, which retains all insoluble matter, and renders the liquid clear, after passing through it; to make a filter, take a piece of filtering paper, five or six inches square, which will be large enough for the funnel before described, and fold the opposite corners together twice, so as to form a conical bag or cup, which is to be placed in the funnel; the funnel may be supported on the tripod, placing a vessel underneath, to catch the filtered liquor. A precipitate may be removed from the filter by means of a knife.

Use of the blowpipe.—The blowpipe is one of the most useful instruments the chemist possesses, as it exerts all the effects of the most powerful furnaces on a small scale, and thus enables him to perform qualitative analyses, and go through many other experiments, that could not otherwise be effected without considerable expense and trouble; it is also of great use in the laboratory, in bending and working glass tubes; it is used to convey a constant current of air through the flame of a lamp, whereby it is converted into a horizontal jet of flame, and an intense heat is excited near the point of it; to keep up a continual blast is generally a matter of no small difficulty to the beginner; he may, however, overcome it by attending to, and practising the following directions. First—Breathe freely through the nostrils, keeping the lips closed. Second—Fill the cheeks with air, breathing as before. Third—Introduce the mouth-piece of the blowpipe between the lips, and force the air from the mouth, by the action of the muscle of the cheeks, supplying air from the the lungs as the cheeks become empty; all this may be soon accomplished by a little practice; the student should avoid blowing too hard, which is a common fault in beginners, as very little more force is required than will suffice to bring the flame of the lamp into a horizontal position.

To bend a glass tube, bring the part to be bent gradually into the blowpipe-flame, and keep it constantly turning round, until it is at a uniform red heat all round; then bend it a little with the hands; apply the heat to the adjoining parts of the tube, in like manner, and bend it again, repeating this operation until the bend has arrived at the required angle: by these means, you may obtain a good round bend, free from wrinkles, which could not be effected if you bent it at once; care should be taken not to remove it from the flame too suddenly, or it will be very brittle and liable to crack, afterwards, when heated; many kinds of glass, when brought into the blue inner part of the flame, receive a permanent black stain from the reduction to the metallic state of the oxide of lead they contain; this may be avoided by keeping it near the point of the yellow part of the flame. In order to have both hands at liberty during blowpipe operations, the jet-pipe of the blowpipe may be passed through a small staple of wire, fixed in the top of a block of wood of the proper height for the lamp.

It may be useful to add a few words on the necessity of order and cleanliness in operating; all bottles and other vessels should be cleaned and put in their proper places after an experiment, that they may be ready for use when wanted again; great care should be taken when experimenting with acids and other corrosive fluids, not to spill, or suffer any to run down the outside of the bottle; no bottle or box should be suffered to remain without a proper label. An old tea tray should be placed on the table when operating, and will be found very useful to save it from the accidental spilling of liquids, and the wear and tear that always accompanies chemical experiments. A due attention to the directions, will add much to the convenience and comfort of the student, and will prevent much mortification and loss, from the failure of experiments.

In conclusion, I would advise the student to buy no article, either of apparatus or materials, until he actually wants it; by this means he will avoid a great deal of unnecessary expense, for articles that he may seldom or never want; for this reason, I have not given any list of chemicals, &c. to be provided, as is generally done in scientific works; it may, however, be necessary to state, that acids, &c. should be preserved in bottles with glass stoppers; all other materials may be kept in common phials, well corked, or in pill boxes.

(To be continued.)

OBSERVATIONS ON BLIGHT.

Blight is a term generally misunderstood, especially among those whom it more particularly concerns. The knowing horticulturist will tell you, "There is blight in the air to-day;" and in a few days or weeks he will see the web of the lackey, or the yellow tail, or the ermine, on his white-thorn hedge-rows; or the caterpillars of the death's-head hawk moth on his potatoes; or those of butterflies on his cabbages; and then he will give you a toss of his wise head, and utter, with a gravity quite in keeping, "I knew there would be a blight this year; I saw it coming in the air." Perhaps, however, he may find a good many snails eating his wall-fruit; or may, perchance, tread on two or three great stag beetles while performing their evening perambulation along his gravelled walks; and then, "he knew it would be either a blight or a sneg; but it's more of a sneg this year." Further than this, the horticulturist has not progressed: webs and soft insects are blights; snails and hard insects are snegs. Warm south-east winds produce the first; cold north-east winds the last; and yet the same man would laugh in your face if you were to say seriously, on a cold misty morning, "There will be a rise in the funds to-morrow, I can see it in the air." I maintain that there can hardly be a greater service performed to horti and agriculturists, than by pointing out to them the nature and habits of their insect enemies; and their laughing at us in the first instance will perhaps be repaid by their thanking us at last.

Let us consider, separately, some of the insects which bear the name of blight. We will, in the first instance, examine the apple-tree. Cider is an important article of manufacture, as well as consumption, in many of our counties; and, consequently, whatever tends to increase or diminish the supply, ought to be deemed by the grower worth his notice. The apple-tree has many assailants: the principal are the weevil, the woolly louse or American blight, and the moth. I will describe the first of these, and its mode of proceeding.

By carefully examining the bark of an apple-tree in the winter, you will occasionally find a pretty little beetle in the cracks, which, directly on being touched, shams dead, and drops on the ground, where you will not, without great difficulty, discover it, on account of the great similarity of its color: you must, therefore, hunt till you find another. This time, as soon as you see him, place one hand below him, then touch him lightly with a little bit of stick, and he will drop into your open hand; his own scheme for self-preservation will beat him. Now roll him into a quill, or pill-box, and take him home. Place him on a sheet of writing paper; you will soon see his shape—the head is furnished with a trunk, from which, on each side, springs a feeler, bent at right-angles forward, so that the trunk altogether looks to be three-pronged, like a trident. The thorax and wing cases are brown, beautifully mottled; and an oblique line on each, pointing towards the suture or meeting of the wing-cases, is much lighter colored, and gives the little beetle an appearance of having a letter V obscurely chalked on its back. Its size altogether is rather less than a hempseed.

With the first sunshiny day in March, these weevils leave their winter quarters, crawl up the trunk and along the twigs, perch themselves so as to receive the full benefit of the sun's rays, and plume themselves with their legs and feet all over, trident and all, just in the same manner that a cat washes her face with her paw; they then stretch out one leg at a time, cramped, no doubt, by the long confinement; they lift up their wing-cases, and unfold two large transparent wings, which, though twice as long as the wing-cases, were neatly folded up and hidden under them, and then, launching themselves into the air, they go roving about the orchards and gardens, their little hearts in an ecstacy of freedom, and love, and happiness. It is not long before each finds a suitable mate: no relations raise objections; and the nuptials are consummated. Now I will allow the gentleman weevil to go his way in quest of new loves and conquests; and in the mean time I will observe the conduct of the lady.

By the time the female is ready for the important task of depositing her eggs, the spring has considerably advanced, the apple-buds have burst, and the little bunches of blossom are readily to be distinguished. The weevil soon finds out these; and selecting a blossom every way to her mind, commences her operations. The beak, or trunk, before alluded to, is furnished at its extremity with short teeth, or mandibles: with these, she gnaws a very minute hole into the calyx of the future blossom, and continues gnawing until her trunk is plunged in up to her eyes; the trunk is then withdrawn, and the hole examined with careful scrutiny by the introduction of one of her feelers, or outer prongs of her trident. If it seem to require any alteration, the trunk goes to work again, and again the feelers; at last, being fully satisfied that the work is well accomplished, she turns about, and standing with the extremity of her abdomen over the hole, thrusts into it her long ovipositor, an instrument composed of a set of tubes retractible one within the other, and deposits a single egg (never more) in the very centre of the future flower. Another examination with her feelers now takes place; and when she is thoroughly satisfied that all is right, away she flies to perform the same operation again and again, never tiring while she has an egg to lay.

The bud continues to grow like the other buds; the little perforation becomes invisible. By and by the egg bursts, and out comes a little white maggot, with neither legs nor wings, which, directly it is hatched, begins to devour the young and tender stamens: next to these, the style is attacked, and eaten down to the fruit, the upper part of which is quickly consumed; the maggot is then full fed; it casts its skin, becomes a chrysalis, and lays perfectly still. Up to this time the blossom has continued healthy, no trace of the enemy being to be discovered without; but when the neighbouring blossoms are expanding their petals to the genial breath of spring, those of the mutilated buds remain closed, and retain the arched balloon-like appearance of a bud about to burst. For a few days they preserve their lovely pink color; and then, by degrees, fade to dingy brown. In this state they remain until the other apples are well knit; and then the damaged blossoms, by their decided contrast, appear very conspicuous. On opening these brown, or rather rust-colored blossoms, about the 10th to the 15th of June, the chrysalis will be found to have changed to a perfect beetle, similar to its parent above described, which, had it been left to itself, would, in a few days, have eaten its way through the weather-beaten case of dry petals, and left its prison-house, flying about to take its pleasure, until the chilly winds of autumn should drive it to its winter habitation under the bark: and in the next spring, the whole round of operations, through which we have watched its parent and itself, would be performed with the same unvarying unerring instinct.

The cloudy misty east wind, in which our farmers and gardeners see the blight, is the very weather of all least favourable to the propagation and increase of these weevils. The fine, clear, sunny days of March and April are the most favourable to them. The tomtits, sparrows, bullfinches, and other birds, which, at this time of year, more particularly frequent orchards and gardens, and which, also, at this time of year, are persecuted with relentless hostility by the farmer and gardener, live, during these months, solely on these weevils, and similar little insects; and, consequently, are the only check on their increase which we possess: so that, in the first investigation of blight, we see how a little prejudice, superstition, and ignorance, tend to increase the injury they dread.

MEMORANDA.

The Paris Telegraphs.—There are in Paris five telegraphs, viz., the central telegraph in the Rue de l'Université, which is about to be transferred to the Ministry of the Interior; the telegraph at the Ministry of Marine, which corresponds with the line of Brest; the telegraph on the church of St. Eustache, for the line of Lille; and the two upon the towers of St. Sulpice, one of which (the north) corresponds with the line of Strasburg, and the other (the south) with Lyons and Italy. At the central station accounts are received from Calais in three minutes, by a line of 27 telegraphs; from Lille in two minutes, by 22 telegraphs; from Strasburg in six minutes, by 46 telegraphs; from Lyons in eight minutes, by 50 telegraphs; and from Brest in eight minutes, by 80 telegraphs.

On Making Bone Glue.—The French have of late years made a considerable quantity of glue from bones, which they consider as superior to the ordinary glue made from the skins of animals.

For the purpose of making this glue, they use the refuse bone of the table knife-makers, and the skulls of oxen, from which the teeth have been extracted. These materials are soaked for about a week in water rendered very sour by the addition of a little spirit of salt; in which time they become quite flexible, and may be bent with ease. Being taken out of the acid, boiling water is poured on the bones, or rather glue, to separate any grease, and also the acid that adheres to it. The pieces of glue are then wiped, washed in cold water, and dried in the shade. When this glue is to be used, it is boiled in water to a proper consistence.

Mineral Tallow.—This rare substance, which was discovered in Finland, in 1736, has lately been found in a bog on the borders of Loch-fyne, in Scotland. It has the color and feel of tallow, and is tasteless. It melts at 118 degrees, and boils at 290 degrees. When melted, it is transparent and colorless; on cooling, it becomes spongy and white, though not so as at first. It is insoluble in water; but soluble in alcohol, oil of turpentine, olive oil, and naphtha, while these liquids are hot, but it is precipitated again when they cool. Its specific gravity, in its natural state, is 0,6078; but the tallow is full of air bubbles; and after fusion, which disengages the air, the specific gravity is 0,983, which is rather higher than that of tallow. It does not combine with alkalies, nor form soap. Thus it differs from every class of bodies known—from the fixed oils in not forming soap; and from the volatile oils and bitumens, in being tasteless and destitute of smell. Its volatility and combustibility are equal to those of any volatile oil or naphtha.—*Edinburgh Philosophical Journal.*

Experiments on Human Hair.—M. Vauguelin, the celebrated French chemist, discovered from some experiments which he made, that black hair is formed of nine different substances, viz. animal matter, a white concrete oil, another greenish grey, one which is very abundant, iron, some particles of oxide of manganese, a phosphate of lime, carbonate of lime, silex, and a considerable quantity of sulphur. Red hair contains red oil in place of a greenish black kind, and white, or very light hair, differs from all the others, as the oil is nearly colorless, and it contains some phosphate of magnesia, which is not found in the others.

Gas from Pyroligneous Acid.—It has lately been discovered that when wood acid is made to pass through an iron tube heated to ignition, and the acid allowed to enter the tube by drops in quick succession, gas of a very excellent quality is obtained. This fact was first observed by Mr. Leet, of this city, whilst pursuing experiments on the purification of pyroligneous acid.—*Chester Paper.*

Steam Engines.—The value of the steam engine to this country may be estimated from calculations which show that the number of steam engines in England represent the power of 320,000 horses, which is equal to that of 1,920,000 men; which being, in fact, managed by 36,000 men only, add actually to the power of our population 1,834,000 men. This is wholly independent of marine and railroad locomotive engines.

Comparative Magnitude of Planets.—Supposing the earth to be 12 inches in diameter, the Herschel is 4 ft. 5 in. Saturn 10 feet, Jupiter 11 ft. 3 in. in diameter. The rest of the planets, which are smaller than the earth, bear the following relative magnitude: Venus 11¾ in., Mars 6¼ in., Mercury 4[illegible] in., Pallas 3¼ in., Juno 2¼ in., Ceres 1½ in., and Vesta only ½ in. in diameter. The comparative diameter of the sun is 111 ft. 8 in. and the moon 3¼ inches.

Horticulture.—D. Powel, Esq., of Loughton, Essex, recommends the following method of securing scions when fitted to the stock in grafting, spread the grafting wax in a melted state evenly on sheets of moderately thin brown paper, and when cold cut it into slips about ¾ of an inch wide; warm one of these slips with the breath, and bind it round the stock and scion, pressing it gently with the hand, when it will be found to adhere so closely as totally to exclude both air and moisture. The wax may be prepared by melting together 1lb. of pitch, 1lb. of resin, ½lb. of bees'-wax, ¼lb. of hogs-lard, and ¼lb. of turpentine. By placing the composition in an earthen pan over boiling water, it may be kept in such a state of fluidity as to be easily spread on the paper with a brush.—*Transactions of the London Horticultural Society.*

Fishing through the Ice.—At Hudson's Bay, in rivers near the sea, and in lakes of a greater depth than ten or twelve feet, fishes are caught all the winter, by cutting holes through the ice down to the water, and putting lines and hooks in them. But in taking them with nets, they cut several holes in a straight line the length of the net, and pass the net with a stick fastened to the head line, from hole to hole, till it reaches the utmost extent; and what fishes come to these holes for air, are entangled in the net; and these fish, as soon as they are brought into the open air, are instantly frozen as stiff as stock-fish.

A Sawing Mill in 1593.—Between Reichstat and Alstat, near Dantzyke, is a mill which, in my opinion is very rare; it is driven by a river, and without the help of hands saweth boords, and having an iron wheele, which doth not only draw the saw, but hooketh in and turneth the boords to the saw.—*Moryson's Travels*, 1593.

The Navigation of the Atlantic by Steam was in 1838 ridiculed as an impossibility; in 1839 it was accomplished; in 1840 vessels steam between Great Britain and the United States as regularly as between London and Leith; and in 1841 it is calculated that there will be 12 steamers, of the total burden of 58,260 tons, employed in this traffic alone.—*Mechanics' Almanack.*

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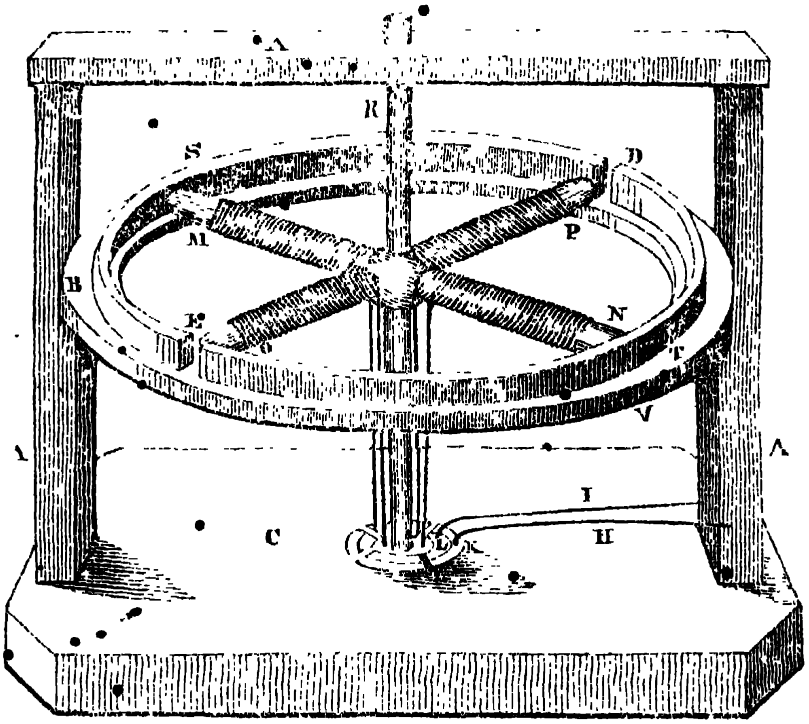
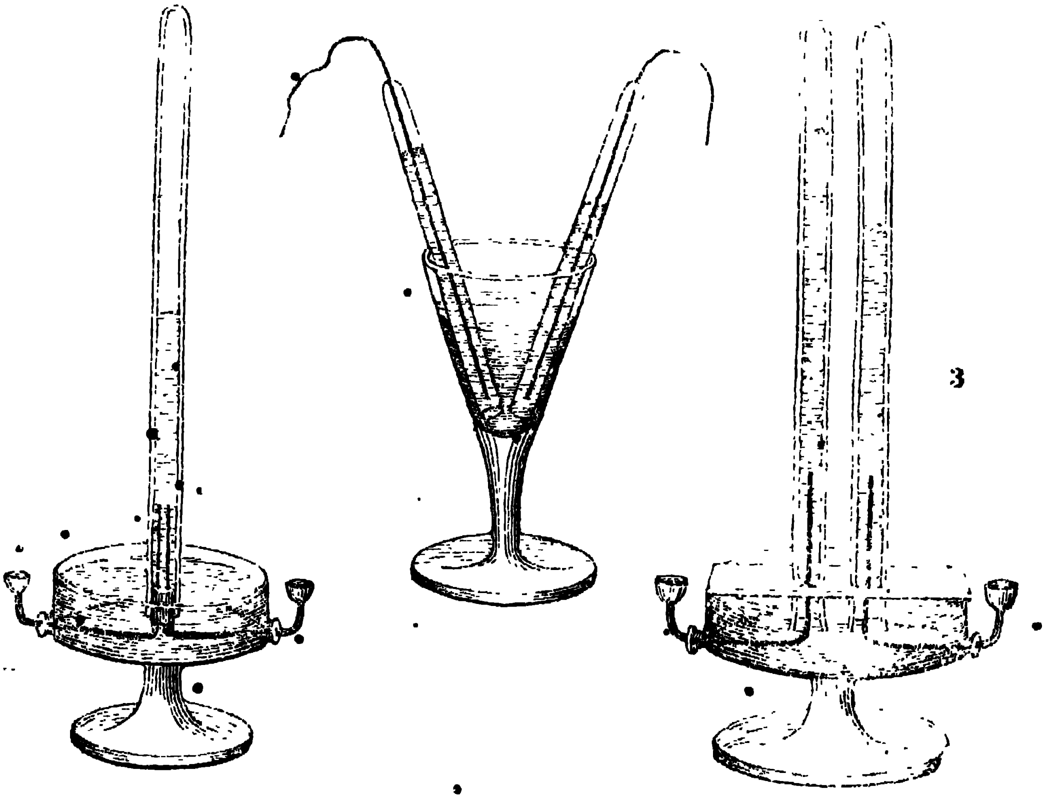


DAVENPORT'S ELECTRO-MAGNETIC ENGINE.



DECOMPOSITION OF WATER BY GALVANISM

DAVENPORT'S ELECTRO-MAGNETIC ENGINE.

The property of electro-magnetism, to produce a strong and rapid rotatory motion of a properly-constructed apparatus, is thought capable of affording a moving power which may, when brought to perfection, supersede the steam engine itself, both in economy, compactness, and facility of management. That such will eventually be the case is extremely probable. The models hitherto constructed have already accomplished much; Professor Jacobi has worked by this means a six-oared cutter with considerable speed. Mr. Sturgeon expresses his opinion of the capability of applying the power to locomotive carriages on common roads; and we have ourselves seen its successful application to the grinding of coffee, the turning of foot-lathes, and other light machines. The attention of the scientific world was first turned to this important subject by the electromotive machine of Mr. Davenport, an American, who obtained a patent for his invention in the year 1837. This patent, however, avails but little, because it is so extremely easy to modify the apparatus into a different form, and in reality to give it greater strength; thus numerous machines of the same kind have been invented, and although Mr. Davenport's is therefore disused, yet being the first of any magnitude, and that which first called forth the inventions of others, it is proper to take notice of it, which we do in the words of the specification, taken from the "Franklin Journal," of November, 1837:—

"The machine for applying the power of magnetism, and electro-magnetism, is described as follows: The frame A A A may be made of a circular, or any other figure, divided into two or more platforms, B and C; upon which the apparatus rests, and of a size and strength adapted for the purpose intended. There are two conductors, H and I, one from the copper, and one from the zinc end of any galvanic battery leading to, and in contact with copper plates, K and L, placed upon the lower platform. These plates, or conductors, are made in the form of a segment of a circle, corresponding in number with the artificial magnets hereinafter described; they are placed around the shaft, detached from one another and from the shaft, having a conductor, leading from the copper-plate of the battery, to one of the said plates on the lower platform, and another conductor leading from the zinc-plate of the battery, and so on alternately around the circle.

"The galvanic magnets, M, N, O, P, are constructed of arms, or pieces, of soft iron, in the shape of a straight bar, horse-shoe, or any other figure, wound with copper wire, first insulated with silk coils: these arms project around it horizontally from the centre of a vertical shaft R, turning on a pivot, or point, in the lower platform; the said copper wires extending from the arms parallel, or nearly so, with the shaft down to the copper-plates, K and L, and in contact with them.

"The artificial magnets S, T, are made of steel, and in the usual manner. They may be of any number, and degree of strength, and fixed on the upper platform, being segments of nearly the same circle as this platform; or if galvanic magnets are used, (which may be done,) they may be made in the form of a crescent or horse-shoe, with their poles pointing to the shaft.

"Having arranged these artificial magnets, on the top of the upper circular platform, there will be a corresponding number of magnetic poles—the north marked D, and the south pole E. Now we will suppose the machine to be in a quiescent state; the galvanic magnet O, being opposite the south pole of the artificial magnets, the galvanic-magnet P, will of course be opposite the south pole E, and the galvanic magnets, M and N will be opposite each other, between the poles just mentioned.

"There being a corresponding number of copper plates, or conductors, placed below the artificial magnets around the shaft, but detached from it, as well as from each other, with wires leading from the galvanic magnets to these plates, and in contact with them, as before described, these wires will stand in the same position, in relation to the copper plates, that the galvanic magnets stand to the artificial magnets, but in contact with the plates.

"Now in order to put the machine in motion, the galvanic magnet M, being charged by the galvanic current passing from the copper plate of the battery, along the conductors and wires, becomes a north pole, whilst, at the same time, the magnet N is charged by the galvanic current passing from the zinc plate of the battery, and becomes a south pole; of course the south pole of the galvanic magnet, E, will attract the north pole of the galvanic magnet M, and will move it a quarter of a circle; the south pole of the galvanic magnet N, being at the same time attracted by the north pole D, causes the said magnet M, also, to perform a quarter of a circle: the momentum of the galvanic arms will carry them past the centres of the poles D and E, at which time the several wires from the galvanic magnets, will have changed their positions in relation to the copper plates, or conductors:—For instance, the north pole M, having now become a south pole, by reason of its wires being brought in contact with the conductors of the zinc plate, and N having, in like manner, become a north pole, its wire having changed its position from the zinc plate to the copper plate, the poles of the galvanic magnets are, of course, now repelled by the poles that before attracted them; and in this manner the operation is continued, producing a rotatory motion in the shaft, which motion is conveyed to machinery, for the purpose of propelling the same."

DECOMPOSITION OF WATER BY GALVANISM.

The chemical powers of the voltaic pile, or galvanic battery, were first observed in regard to the decomposition of water by Messrs. Carlisle and Nicholson, in the year 1800. These were then more accurately investigated in 1803, by Hisinger and Berzelius, and in 1807, Sir H. Davy communicated his celebrated lecture "On some Chemical Agencies of Electricity," to the Royal Society, in which the electro-chemical powers of the pile were elaborately examined, and which formed the ground work of the brilliant discoveries to which he was soon afterwards lead by the prosecution and extension of his researches. There were, however, many important phenomena, more especially those connected with the development of electricity by chemical action, and with the theory of electro-chemical decomposition, which Sir H. Davy and others, whose researches have enlightened this difficult department of electrical science, either left unexplored, or insufficiently and unsatisfactorily explained; these have lately engaged the attention of Professor Faraday, and his "Experimental Researches in Electricity," published first in a succession of papers in the "Transactions of the Royal

Society,'* and lately in a distinct volume, contain the result of his labors in reference to this branch of knowledge.

When the conducting wires from the extremes of the voltaic pile or battery, are brought near to each other in certain liquids, such for instance as *water* and *saline solutions*: or in other words, when these liquids make part of the electric circuit, so that the current of the electricity passes through them, they are *decomposed*; that is, they yield up their elements in obedience to certain laws; water for instance is resolved into *hydrogen* and *oxygen*. In these cases the elements appear at the poles or electrodes, not indiscriminately, or indifferently, but the oxygen is developed at the *anode*, or surface by which the electricity enters the water and the hydrogen at the *cathode*, or surface by which the electric current leaves the body under decomposition.

To show the manner in which water is decomposed, and to conduct the operation with neatness, convenience, and certainty, many contrivances may be devised. The following will illustrate the subject more fully:—If two plates or strips of platina foil, connected with the ends of the voltaic battery, be brought near to each other in a glass of water, a stream of glass will issue from each, which, in an apparatus similar to either of those represented in the cut, may be collected, and submitted to examination.

Fig. 1 represents the glass of water, and the two platinum wires, each inclosed in a glass tube. The gases, when liberated, will ascend the tubes, and be accumulated in them. Fig. 2 represents a more convenient apparatus, but one in which the liberated gases are both contained in the same tube. It consists of a wide-mouthed glass with a foot to it, and two necks, one on each side. In the necks are fixed, water-tightly, the two wires, the outer ends of them being furnished with mercury cups, and the inner ends turned up, made to pass through a cork, and remain an inch or two above it. The glass tube which is to catch the gas is fixed over the cork. Fig. 3 is a representation of a far superior instrument, the structure of which will be readily understood, premising only that the two glass tubes are fixed to a brass plate which fits on to the top of the wide lower glass.

It will be observed, that twice the quantity of gas escapes at the negative pole, or *cathode* of the water, as compared with that at the positive pole, or at the *anode* of the water. When a single tube is used, it will be found to contain a mixture of oxygen and hydrogen gases, in the proportion of two volumns of the former to one of the latter. If a lighted candle be brought to the mouth of the tube, the mixed gases explode and disappear, re-producing the exact quantity of water decomposed. In using the double-tubed apparatus, it will be seen that *two* volumns of *hydrogen*, and one volumn of oxygen are respectively collected in the tubes inverted over the negative and positive wires. Upon the approach of a taper, the hydrogen gas will burn quietly with a lambent blue flame; and the oxygen may be recognised by immersing into it the glowing wick of a small piece of a taper, which will instantly kindle into a flame.

HEIGHT OF THE ATMOSPHERE.

VARIOUS attempts have been made to ascertain the height to which the atmosphere is extended all round the earth. These commenced soon after it was discovered, by means of the Torricellian tube, that air is a gravitating substance. Thus it also became known, that a column of air, whose base is a square inch, and the height that of the whole atmosphere, weighs 15 pounds; and that the weight of it is to that of mercury as 1 to 10,800: whence it follows, that if the weight of the atmosphere be sufficient to raise a column of mercury to the height of 30 inches, the height of the aerial column must be 10,800 times as much, and consequently a little more than five miles high.

It was not, however, at any time supposed, that this calculation could be just; for, as the air is an elastic fluid, the upper parts must expand to an immense bulk, and thus render the calculation above related exceedingly erroneous. By experiments made in different countries, it has been found, that the spaces which any portion takes up, are reciprocally proportional to the weights with which it is compressed. Allowances were to be made in calculating the height of the atmosphere. If we suppose the height of the whole divided into innumerable equal parts, the density of each part of which is as its quantity; and the weight of the whole incumbent atmosphere being also as its quantity; it is evident, that the weight of the incumbent air is everywhere as the quantity contained in the subjacent part; which makes a difference between the weights of each two contiguous parts of air. By a theorem in geometry, where the differences of magnitudes are geometrically in proportion to the magnitudes, these magnitudes are in continual arithmetical progression; therefore, if, according to the supposition, the altitude of the air, by the addition of new parts into which it is divided, do continually increase in arithmetical proportion, its density will be diminished, or (which is the same thing, its gravity decreased) in continual geometrical proportion.

It is now easy, from such a series, by making two or three barometrical observations, and determining the density of the atmosphere at two or three different stations, to determine its absolute height, or its rarity at any assignable height. Calculations accordingly were made upon this plan; but it having been found that the barometrical observation by no means corresponded with the density which, by other experiments, the air ought to have had, it was suspected that the upper parts of the spherical regions were not subject to the same laws with the lower ones. Philosophers had recourse to another method for determining the altitude of the atmosphere, viz., by a calculation of the height from which the light of the sun is refracted, so as to become visible to us before he himself is seen in the heavens. By this method it was determined, that at the height of 45 miles the atmosphere had no power of refraction; and consequently beyond that distance was either a mere vacuum, or the next thing to it, and not to be regarded. This theory soon became very generally received, and the height of the atmosphere was spoken of as familiarly as that of a mountain, and reckoned to be as well ascertained, if not more so, than the heights of most mountains are. Very great objections, however, which have never yet been removed, arise from the appearance of some meteors, like large globes of fire, are not unfrequently to be seen at vast heights above the earth. A very remarkable one of this kind was observed by Dr. Halley, in the month of March, 1719, the altitude of which he computed to have been between

69 and 73½ English miles; its diameter 2800 yards, or upwards of a mile and a half; and its velocity about 350 miles in a minute. Others, apparently of the same kind, but whose altitude and velocity were still greater, have been observed; particularly that remarkable one, August 18th, 1783, whose distance from the earth could not be less than 90 miles, and its diameter not less than the former; at the same time that its velocity was certainly not less than a thousand miles in a minute. Fire-balls, in appearance similar to these, though vastly inferior in size, have been sometimes observed at the surface of the earth. Of this kind Dr. Priestley mentions one seen on board the Montague, the 4th of November, 1719, which appeared as big as a large millstone, and broke with a violent explosion.

From analogical reasoning, it seems very probable, that the meteors which appear at such great heights in the air are not essentially different from those which, like the fire-ball just mentioned, are met with on the surface of the earth. The perplexing circumstances with regard to the former are, that at the great heights above mentioned, the atmosphere ought not to have any density sufficient to support flame, or to propagate sound; yet these meteors are commonly succeeded by one or more explosions—nay, are sometimes said to be accompanied with a hissing noise as they pass over our heads. The meteor of 1719 was not only very bright, insomuch that, for a short space, it turned night into day, but was attended with an explosion heard over all the island of Britain, occasioning a violent concussion in the atmosphere, and seeming to shake the earth itself. That of 1783 also, though much higher than the former, was succeeded by explosions, and, according to the testimony of several people, a hissing noise was heard as it passed. Dr. Halley acknowledged that he was unable to reconcile these circumstances with the received theory of the height of the atmosphere; as, in the regions in which this meteor moved, the air ought to have been 300,300 times more rare than what we breathe, and the next thing to a perfect vacuum.

In the meteor of 1783, the difficulty is still greater, as it appears to have been 20 miles farther up in the air. Dr. Halley offers a conjecture, indeed, that the vast magnitudes of such bodies might compensate for the thinness of the medium in which they moved. Whether or not this was the case cannot indeed be ascertained, as we have so few data to go upon; but the greatest difficulty is to account for the brightness of the light. Appearances of this kind are, indeed, with great probability, attributed to electricity, but the difficulty is not thus removed.

It appears that the absolute height of the atmosphere is not yet determined. The beginning and ending of twilight indeed show, that the height at which the atmosphere begins to refract the sun's light, is about 44 or 45 English miles. But this may not improbably be only the height to which the aqueous vapors are carried; for it cannot be thought any unreasonable supposition, that light is refracted only by means of the aqueous vapor contained in the atmosphere; and where this ceases, it is still capable of supporting the electric fire at least as bright and strong as at the surface. That it does extend much higher, is evident from the meteors already mentioned; for all these are undoubtedly carried along with the atmosphere: otherwise, that of 1783, which was seen for about a minute, must have been left 1000 miles to the westward, by the earth flying out below it in its annual course round the sun.

COMBINED ZINCING AND TINNING.

A PATENT has been granted in the United States to Messrs. Summer and Naylor, of New York, for an improvement in the process of tinning iron to prevent it from rusting, and also to obviate the inconvenience of zincing iron, which arises from its diminished malleability. The invention is an improvement on one for zincing iron for which a patent was granted, in 1837, to M. Sorel. In the specification of their invention the patentees state, that having become proprietors by assignment of M. Sorel's patent process, in carrying the same into practical operation they found that the malleability of sheet-iron is much impaired by giving it a coating of zinc in the manner directed by M. Sorel; and that, in consequence of this diminished malleability, such prepared sheet iron is unsuited, in many cases, to be applied to the purpose of covering the roofs of houses, or to be otherwise used where it is required to be grooved, seamed, or in any way suddenly bent. This improvement consists in a process by which this difficulty is obviated, whilst the zinc is at the same time so applied as by its galvanic action on the iron to protect it from oxidation. Their mode of proceeding is thus described:—"We take sheets of iron, and cover them with tin, or with an alloy of tin and lead, adopting in this process the mode or modes followed in the well-known manufacture of sheets or plates of iron into tin plate. After having completed this operation, we submit the sheets or plates so prepared to a like process, with the substitution of zinc for tin, or an alloy of tin; the mode of performing which does not differ from the ordinary process known under the name of tinning. When thus treated, the plates or sheets of iron preserve their malleability unimpaired, and may be bent and otherwise worked as easily as before they had received such coating—a result which appears to be due to the interposition of the coating of tin between the zinc and the iron, by which interposition the chemical combination of the iron and zinc is prevented. Where it is not necessary to use plates of metal of a larger size than that of sheets of tin plate, we take that material as it comes from the manufactories, and have then only to give to it a coating of zinc, to receive which does not require any particular preparation. In the letters patent granted to M. Sorel, it is proposed, sometimes to add a coating of tin over that of the zinc, for the purpose of giving to the article made a brighter appearance, and as an improvement also in culinary vessels; but our process is the reverse of this, and the end attained by us altogether different from that above proposed, and, at the same time, our process produces a new and useful result. What we claim, therefore, as our invention, and as an improvement on the process of M. Sorel, is the preserving the malleability of sheet iron, whilst it is protected from oxidation by the galvanic action between it and the zinc, in the manner above set forth—namely, by first tinning the said iron in the ordinary way, and afterwards by giving thereto a coating of zinc above the tin."

AMIANTHUS, OR MOUNTAIN FLAX,

Is a fibrous elastic mineral substance, of a silvery whiteness or greenish color; lustre glimmering, of a pearly or silken appearance. It is soft enough to be scratched by the nail, and considerably elastic. It has a soft and somewhat greasy feel;—specific gravity about 9,400. This mineral is usually met with dispersed in rocks of serpentine, but it is found in Germany in the strata of iron ore, sometimes forming a vein of an inch in diameter. It is found also at Crete, Cyprus, Elba, and Corsica; in France, Sweden, Siberia, and in the mountains of Arcadia; also in various parts of Great Britain, but particularly at Anglesea in Wales, and Aberdeenshire in Scotland. The Tarentaise amianthus from Savoy is the most beautiful.

Exposed to the action of the blow-pipe, the Tarentaise amianthus fuses into an opaque substance. It dissolves quickly in borax and microcosmic salt, but effervesces with carbonated soda. The mineral acids have a very feeble action on amianthus. It appears, from Bergman, that caustic potash affords the means of dissolving this substance, which he effected by mixing equal parts of amianthus, carbonated potash, and charcoal, and igniting them for two hours, by which he obtained a mass that was perfectly soluble in nitro-muriatic acid; 100 parts of the Tarentaise amianthus yielded, according to Bergman, sulphated barytes 6.0; carbonated lime 6.9; carbonated magnesia 18.6; alumine 3.3; silex 61.0; oxide of iron 1.2.

The ingenuity of man, two thousand years since, led to the fabrication of a peculiar kind of cloth from the filaments of this extraordinary mineral; possessing the wonderful quality of being inconsumable in fire. When the cloth became dirtied or greased, it was usual to throw it into a bright fire; the stains were thus burnt out, and the cloth purified and rendered of a dazzling whiteness. Pliny states that he had been an eye witness to this operation. In the luxurious times of the Roman empire, this cloth was purchased at an enormous price, for the purpose of wrapping up the bodies of the dead, before being laid on the funeral pile: the ashes of the body were thus preserved unmixed with those of the wood. Of the reality of this practice there cannot exist a doubt; in 1702 a skull and other calcined bones, together with a quantity of ashes, were discovered at Porta Naevia at Rome, which were enwrapped in amianthus cloth; which interesting relic of antiquity is now preserved in the Vatican library.

The practice of burning the dead becoming disused, the manufacture of amianthus cloth was neglected, and the art was lost in Europe. It is said, however, that the art is still preserved in the east, and the cloth employed by the Tartars in burning the bodies of the dead.

In 1691, Sig. Ciampini, of Rome, published the following method of manufacturing this incombustible cloth:—The amianthus is to be first laid in warm water to soak for some time; it is then to be opened and divided by the hands by gentle rubbing; all the extraneous earthy matters will thus be loosened and washed out, which, in the natural state, serve to bind the fibres together. This operation is to be repeated several times by pouring on boiling water, and opening and squeezing the mineral till the water runs off quite clear. Nothing will now be left but long flax-like fibres, which are to be laid in a sieve and dried in the sun. It is then to be carded (or combed) on very fine cards, and the long filaments are to be steeped in oil to render them more flexible. It is then to be placed between the card in such a manner that a portion of it may hang out at the sides. The spinning of it is performed by fixing a small reel with a little hook at the end on the same bench as the cards. The reel is to be wound over with white thread, which twisting about the thread placed in contact with the amianthus, the latter, by the assistance of the thumb and fore-finger of the operator, is wound up and twisted with it into one thread. A continuous thread being thus produced, it is carefully woven into cloth; placed afterwards in a clear charcoal fire, both the oil and the thread of linen or cotton that was combined with it in the spinning and weaving are consumed, and there remains a pure tissue of white amianthus. This method being, however, very tedious, another has been recommended; which is to place a quantity of flax on a distaff, and taking three or four filaments of the amianthus between the fingers, they may be easily mixed and twisted along with the flax. The thread thus spun will be much stronger and more durable than that made by the abovementioned process; the carding will also be unnecessary, by which many of the filaments are unavoidably broken.

The short filaments that remain after the washing or carding of the stone, have been made into paper by the ordinary method of manufacturing that substance, except that a larger portion of size is employed. As it would be worth while to preserve documents of great importance by writing on the amianthus paper with an indelible ink, that would also resist the effects of fire, the following receipt has been given for that purpose:—To one part of of sulphate of iron add two parts of alum, which having dissolved in hot water, add pearlash as long as any precipitate takes place: the mixture is next to be boiled, then filtered, and the precipitate well washed with warm water; distilled vinegar is then to be added to the precipitate, which will dissolve it and form an indelible ink. Amianthus paper being written upon with this preparation, the characters will be preserved after combustion, of a brown color, and perfectly legible.

Threads of the amianthus are sometimes used as perpetual wicks for lamps. Amianthus is frequently confounded with the more flexible kinds of asbestos. By some writers the terms are used synonymously. Others divide the asbestos into several varieties, of which amianthus is one.

THE TIDES.

(Resumed from page 36, and concluded.)

The periodic motions of the waters of the ocean, on the hypothesis of an ellipsoid of revolutions entirely covered by the sea, are very far from according with observation. This arises from the very great irregularities in the surface of the earth, which is but partially covered by the sea, from the variety in the depths of the ocean, the manner in which it is spread out on the earth, the position and inclinations of the shores, the currents, and the resistance the waters meet with: causes impossible to estimate, but which modify the oscillations of the great mass of the ocean. However, amidst all these irregularities, the ebb and flow of the sea maintain a ratio to the forces producing them sufficient to indicate their nature, and to verify the law of the attraction of the sun and moon on the sea. La Place observes, that the investigation of such relations between cause and effect, is no less useful in natural philosophy than the direct solution of problems, either to prove the existence of the causes, or to trace the laws of their effects. Like the theory of probabilities, it is a happy supplement to the ignorance and weakness of the human mind.—Thus the problem of the tides does not admit of a general solution. It is indeed necessary to analyse the general phenomena which ought to result from the attraction of the sun and moon, but these must be corrected in each particular case by local observations modified by the extent and depth of the sea, and the peculiar circumstances of the place.

Since the disturbing action of the sun and moon can only become sensible in a very great extent of water, the Pacific Ocean must be one of the principal sources of our tides. But, in consequence of the rotation of the earth, and the inertia of the ocean, high water does not happen till some time after the moon's southing. The tide raised in that world of waters is transmitted to the Atlantic, from which sea it moves in a northerly direction along the coasts of Africa and Europe, arriving later and later at each place. This great wave, however, is modified by the tide raised in the Atlantic, which sometimes combines with that from the Pacific in raising the sea, and sometimes is in opposition to it, so that the tides only rise in proportion to their difference. This vast combined wave, reflected by the shores of the Atlantic, extending nearly from pole to pole, still coming northward, pours through the Irish and British Channels into the North Sea, so that the tides in our ports are modified by those of another hemisphere. Thus the theory of the tides in each port, both as to their height and the times at which they take place, is really a matter of experiment, and can only be perfectly determined by the mean of a very great number of observations, including several revolutions of the moon's nodes.

The height to which the tides rise is much greater in narrow channels than in the open sea, on account of the obstructions they meet with. The sea is so pent up in the British Channel, that the tides sometimes rise as much as fifty feet at St. Malo, on the coast of France; whereas, on the shores of some of the South Sea islands, near the centre of the Pacific, they do not exceed one or two feet. The winds have great influence on the height of the tides, according as they conspire with, or oppose them. But the actual effect of the wind in exciting the waves of the ocean extends very little below the surface. Even in the most violent storms, the water is probably calm at the depth of ninety or a hundred feet. The tidal wave of the ocean does not reach the Mediterranean nor the Baltic, partly from their position and partly from the narrowness of the Straits of Gibraltar and of the Categat, but it is very perceptible in the Red Sea and in Hudson's Bay. In high latitudes, where the ocean is less directly under the influence of the luminaries, the rise and fall of the sea is considerable, so that, in all probability, there is no tide at the poles, or only a small annual and monthly tide. The ebb and flow of the sea are perceptible in rivers to a very great distance from their estuaries. In the Straits of Pauxis, in the river of the Amazons, more than five hundred miles from the sea, the tides are evident. It requires so many days for the tide to ascend this mighty stream, that the returning tides meet a succession of those which are coming up; so that every possible variety occurs at some part or other of its shores, both as to magnitude and time. It requires a very wide expanse of water to accumulate the impulse of the sun and moon, so as to render their influence sensible; on that account the tides in the Mediterranean and Black Sea are scarcely perceptible.

These perpetual commotions in the waters are occasioned by forces that bear a very small proportion to terrestrial gravitation: the sun's action in raising the ocean is only the 1-38448000 of gravitation at the earth's surface, and the action of the moon is little more than twice as much; these forces being in the ratio of 1 to 2·35333, when the sun and moon are at their mean distances from the earth. From this ratio, the mass of the moon is found to be only the 1-75 part of that of the earth. Had the action of the sun on the ocean been exactly equal to that of the moon, there would have been no neap tides, and the spring tides would have been of twice the height which the action of either the sun or moon would have produced separately; a phenomenon depending upon the interference of the waves or undulations.

A stone plunged into a pool of still water occasions a series of waves to advance along the surface, though the water itself is not carried forward, but only rises into heights and sinks into hollows, each portion of the surface being elevated and depressed in its turn. Another stone of the same size, thrown into the water near the first, will occasion a similar set of undulations. Then, if an equal and similar wave from each stone arrive at the same spot at the same time, so that the elevation of the one exactly coincides with the elevation of the other, their united effect will produce a wave twice the size of either. But if one wave precede the other by exactly half an undulation, the elevation of the one will coincide with the hollow of the other, and the hollow of the one with the elevation of the other;—and the waves will so entirely obliterate one another, that the surface of the water will remain smooth and level. Hence, if the length of each wave be represented by 1, they will destroy one another at intervals of 1-2, 3-2, 5-2, &c., and will combine their effects at the intervals, 1, 2, 3, &c. It will be found, according to this principle, when still water is disturbed by the fall of two equal stones, that there are certain lines on the surface, of a hyperbolic form, where the water is smooth in consequence of the waves obliterating each other; and that the elevation of the water in the adjacent parts corresponds to both the waves united. Now, in the spring and neap tides, arising from the combination of the simple soli-lunar waves, the spring tide is the joint result of the combination when they coincide in time and place; and the neap tide happens when they succeed each other by half an interval, so as to leave only the effect of their difference sensible. It is, therefore, evident that, if the solar and lunar tides were of the same height, there would be no difference, consequently no neap tides, and the spring tides would be twice as high as either separately. In the port of Batsha, in Tonquin, where the tides arrive by two channels, of lengths corresponding to half an interval, there is neither high nor low water, on account of the interference of the waves.

The initial state of the ocean has no influence on the tides; for, whatever its primitive conditions may have been, they must soon have vanished by the friction and mobility of the fluid. One of the most remarkable circumstances in the theory of the tides is the assurance that, in consequence of the density of the sea being only one-fifth of the mean density of the earth, and the earth itself increasing in density towards the centre, the stability of the equilibrium of the ocean never can be subverted by any physical cause. A general inundation, arising from the mere instability of the ocean, is, therefore, impossible. A variety of circumstances, however, tend to produce partial variations in the equilibrium of the seas, which is restored by means of currents. Winds, and the periodical melting of the ice at the poles, occasion temporary water-courses; but by far the most important causes are the centrifugal force induced by the velocity of the earth's rotation, and variations in the density of the sea.

The centrifugal force may be resolved into two forces—one perpendicular, and another a tangent to the earth's surface. The tangential force, though small, is sufficient to make the fluid particles within the polar circles tend towards the equator, and the tendency is much increased by the immense evaporation in the equatorial regions, from the heat of the sun, which disturbs the equilibrium of the ocean. To this may also be added the superior density of the waters near the poles, partly from their low temperature, and partly from their gravitation being less diminished by the action of the sun and moon than that of the seas of lower latitudes. In consequence of the combination of all these circumstances, two great currents perpetually set from each pole towards the equator. But, as they come from latitudes where the rotatory motion of the surface of the earth is very much less than it is between the tropics on account of their inertia, they do not immediately acquire the velocity with which the solid part of the earth's surface is revolving at the equatorial regions; from whence it follows that, within twenty-five or thirty degrees on each side of the line, the ocean appears to have a general motion from east to west, which is much increased by the action of the trade winds. This mighty mass of rushing waters, at about the tenth degree of south latitude, is turned towards the north-west by the coast of America, runs through the Gulf of Mexico, and, passing the Straits of Florida at the rate of five miles an hour, forms the well-known current of the Gulf-stream, which sweeps along the whole coast of America, and runs northward as far as the bank of Newfoundland; whence, bending to the east, it flows past the Azores and Canary Islands, till it joins the great westerly current of the tropics about latitude 21° north. According to M. de Humboldt, this great circuit of 3800 leagues, which the waters of the Atlantic are perpetually describing between the parallels of eleven and forty-three degrees of latitude, may be accomplished by any one particle in two years and ten months. In the centre of this current is situated the wide field of floating sea-weed, called the grassy sea. Besides this, there are branches of the Gulf-stream, which convey the fruits, seeds, and a portion of the warmth of the tropical climates to our northern shores.

The general westward motion of the South Sea, together with the south polar current, produces various water-courses in the Pacific and Indian Oceans, according as the one or the other prevails. The western sea of the Pacific, causes currents to pass on each side of Australia, while the polar stream rushes along the Bay of Bengal: the westerly current again becomes most powerful towards Ceylon and the Maldives, whence it stretches by the extremity of the Indian peninsula, past Madagascar, to the most northern point of the continent of Africa, where it mingles with the general motion of the seas. Icebergs are sometimes drifted as far as the Azores from the north pole, and from the south pole they have come even to the Cape of Good Hope. But the ice which encircles the south pole, extends to lower latitudes by 10° than that which surrounds the north. In consequence of the polar current, Sir Edward Parry was obliged to give up his attempt to reach the north pole in the year 1827, because the fields of ice were drifting to the south faster than his party could travel over them to the north.

As distinct currents of air traverse the atmosphere in horizontal strata, so, in all probability, under currents in the ocean flow in opposite directions from those on the surface, but it is not easy to prove their existence. It is supposed that an under current from the Mediterranean sets in through the Straits of Gibraltar. The surface stream flows the contrary way.

HINTS ON THE MICROSCOPE.

To the Editor.

Sir.—If you think the following remarks worthy of insertion in your very valuable and interesting journal, you will oblige me by inserting them. I am sure they will prove interesting to many of your readers; there is nothing original in them, but I think, perhaps, the generality of your readers may not have met with them—they are all relating to the microscope. One very interesting subject is, the examination of the pollen tubes, or boycaux of different plants; I believe Dr. Aldridge, of Dublin, in an elaborate memoir, first showed the method of obtaining them in the same state as that in which they perforate the stigmatic tissue. They are readily obtained from any pollen merely by acting upon it by dilute acids, nitric (1 to 7 of water) is perhaps, the best; if a drop or two of this be placed upon one of the glass slides, and the pollen sprinkled upon it, or what is better, if the stamens of a flower be touched with the slide, then the dilute acid dropped upon it, in a few minutes, by the aid of a very moderate microscope, the tubes will be seen shooting out beautifully. If they do not readily come forth, heating the slide very slightly will produce the effect. Dr. Aldridge says they are eliminated upon the stigma by the acid which he says is always found there. I have not been able to detect this acidity of the stigma myself, but, perhaps, it may prove interesting to yourself or your readers to experiment for themselves. Another very interesting phenomenon is the production of the Torulo, and mycoderma cerevisiæ, as described by Dr. Maudl, in his "Traité prætique du Microscope;" these are readily seen by putting a small portion of yeast into some weak syrup, and allowing it to remain there for two or three days; when elongated, filiform, jointed bodies (the above named vegetable productions) will be seen springing out, if these are allowed to remain they will increase to a considerable size. These and several other objects (such as are spoilt by drying, but are prepared by means of water,) are best preserved as mentioned by Dr. Maudl, by making some very thick syrup, and preparing them with this in the same manner as we use Canada balsam. Spiral vessels, stomata of plants, and pollen tubes, &c., are beautifully preserved thus.—The syrup should be made in the ordinary way, as in medicine, only it should not be stirred till cold, as by allowing it to stand any excess of sugar is precipitated in crystals, which might take place in the slide of our object, unless avoided thus:—when objects are preserved in this manner, they should be subjected to considerable pressure until they are thoroughly dry, and then the spaces existing between the glass plate should be filled (by capillarity) with white hard spirit varnish; in this manner they are beautifully and permanently preserved. Spiral vessels are very easily observed in any phænogamous plant, but the conical terminations are very difficult to procure in the ordinary way; we are directed to boil the bulb of a hyacinth, then dissect out the spiral vessels; but the easiest plan is to take the flower of a hyacinth, put it into some soft water, let it remain until the water becomes slightly putrid, when the flowers will be found almost exactly like a jelly, the spiral vessels are very easily separated, pick off one of the segments of the perianth, press it firmly between two glass sides, when towards the apex of the segment the terminations will be readily and abundantly seen, or they may be dissected from the macerated segment very easily, as they are so few in number; if, after being laid between the glass slides, the slides are kept pressed firmly in a small press, and then the spaces between the glasses filled, as mentioned above, with white hard varnish, they may be permanently preserved unaltered.

A beautiful example of cellular tissue is seen in the fronds of Hymenophyllum Tunbrigense: they have particles of green matter in their interior. It requires a very perfect microscope to define the green particles, but they are the most beautiful objects I ever saw. Thick gum is sometimes employed instead of the syrup, but it is not so good.

J. W. G.

MISCELLANEOUS EXPERIMENTS.

Take a small phial about half full of cold water, grasp it gently in the left hand, and from another phial pour a little sulphuric acid very gradually into the water. A strong *sensation of heat* will immediately be perceived. This, by the continued addition of the acid, may be increased to many degrees beyond that of boiling water.

Dissolve one ounce of quicksilver, *without* heat, in ¾ of an ounce of strong nitrous acid, previously diluted with one ounce and a half of water. Dissolve also the same weight of quicksilver, *by means of heat*, in the same quantity of a similar acid, and then, to each of these colorless solutions, add a colorless solution of ammonia. In the one case, the metal will be precipitated in a *black*, in the other, in a *white* powder, affording an example of the difference of color of metallic oxides, arising from *different degrees of oxidizement.*

Write with acetate of cobalt, or with a muriate of cobalt, previously purified from the iron which it generally contains. When the writing is become dry, these letters will also be invisible. Warm the paper a little, and the writing will be restored to a beautiful *blue.*

Put a little fresh calcined magnesia in a tea-cup upon the hearth, and suddenly pour over it as much concentrated sulphuric acid as will cover the magnesia. In an instant sparks will be thrown out, and the mixture will be *completely ignited.*

Put a little oxymuriate of potass and a bit of phosphorus into an ale glass, pour some cold water upon them cautiously, so as not to displace the salt. Now take a small glass tube, and plunge it into some sulphuric acid; then place the thumb upon the upper orifice, and, in this state, withdraw the tube, which must be instantly immersed in the glass, so that, on removing the thumb, the acid may be immediately conveyed upon the ingredients. This experiment is an example of a very singular phenomenon, *combustion under water.*

Proceed, in all respects, as in the last experiment, and add a morsel of phosphuret of lime.—Here, besides the former appearance, we shall have *combustion* also *on the surface of the water.*

Mix one ounce of litharge of lead with one drachm of pulverized muriate of ammonia, and submit the mixture to a red heat in a clean tobacco-pipe. The increase of temperature will separate the ammonia in the form of gas, and the muriatic acid will combine with the lead. When the compound is well melted, pour it into a metallic cup, and you will have a true *muriate of lead* of a bright yellow color, the brilliancy of which may be much heightened by grinding it as usual with oil. In this state it forms the color called *patent yellow.*

Take one ounce of red-lead, and half a drachm of charcoal, in powder, incorporate them well in a mortar, and then fill the bowl of a tobacco-pipe with the mixture. Submit it to an intense heat in a common fire, and, when melted, pour it upon a slab. The result will be *metallic lead* completely revived.

Take a little red-lead, expose it to an intense heat in a crucible, and pour it out when melted. The result will be metallic glass, and will furnish an example of the *vitrification of metals.*

Boil equal parts of annatto and common potass in water till the whole are dissolved. This will produce the *pale reddish buff* so much in use, and sold under the name of *nankeen dye.*

If muriate of tin, newly made, be added to a solution of indigo in sulphuric acid, the oxygen of the indigo will be absorbed, and the solution instantly converted to a *green.* It is on the same principle that muriate of tin is employed in cleansing discoloured leather furniture; as it absorbs the oxygen, and the *leather is restored to its natural color*

Write with dilute nitrate of silver, which, when dry, will be entirely invisible; hold the paper over a vessel containing sulphate of ammonia, and the writing will appear very distinct. The letters will shine with the *metallic brilliancy of silver.*

Write with a solution of muriate of cobalt, and the writing, while dry, will not be perceptible, but if held towards the fire, it will then gradually become visible, and if the muriate of cobalt be made in the usual way, the letters will appear of an elegant *green* color.

Take two grains of oxymuriate of potass, with three or four grains of flour sulphur, and mix the ingredients very well on paper. If a little of this mixture be taken up on the point of a knife, and dropped into a wine-glass containing some sulphuric acid, a beautiful *column of flame* will be perceived, the moment the powder comes in contact with the acid.

Take a small phial, in one hand, containing some pulverized muriate of ammonia; pour a little water upon it, and shake the mixture. In this instance a *sensation of cold* will immediately be felt.

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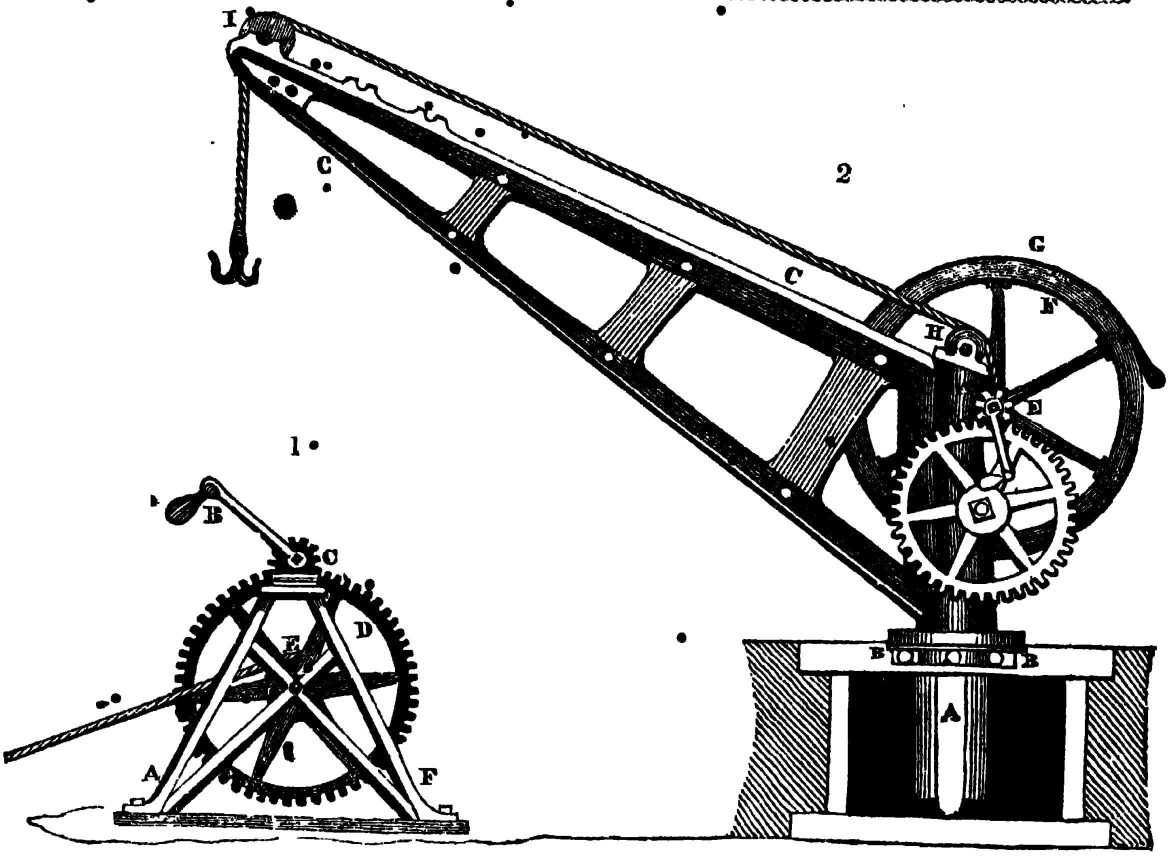
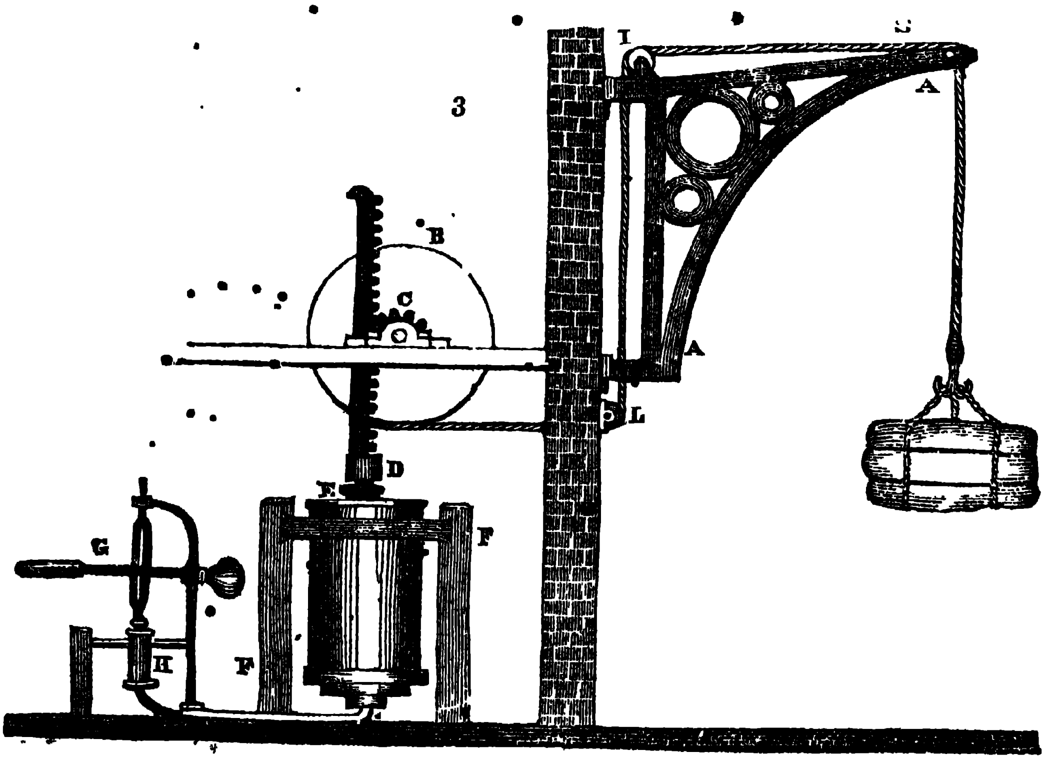


CRANES FOR RAISING AND LOWERING WEIGHTS.



CRANES FOR RAISING WEIGHTS.

CRANES are certain simple machines in which either the wheel and axle, or wheel and pinion, are introduced, to effect the raising of heavy loads, such as the loading or unloading of shipping at the quays or wharfs, or the raising or lowering goods to and from chambers or warehouses.

Various modes have been adopted to turn the wheel, or that part of the machine which is applied to the same purpose, by introducing long staves into the axle, by which it acquires the name of a capstan, or windlass; or by a rope passing over the wheel, and putting it and the axle in motion by friction. Other methods have been adopted, such as forming the wheel hollow, and causing it to revolve by means of laborers inside of it, walking up its side, which consequently descends beneath their weight; or by forming it into a platform, lying in a slanting direction, and the laborers pushing against a fixed arm, which forces the platform or wheel round under their feet.

Most of the cranes constructed with the wheel and axle occupy too much space, which is of importance, and, consequently, where cranes are in general use, have been superseded by the wheel and pinion, which is of a more compact and convenient construction. The wheel and pinion is generally accompanied with a ratchet-wheel and pall, or some other method of locking the handle, so that, should the laborer desist from his exertion, the load may not return to the place from whence it has been raised.

The frame-work, or that part of the crane which does not immediately operate to raise the load, is divided into three parts, the post, the jib, and the stay. The post is the upright piece, almost universally made to turn on a centre; the jib is the arm extending from the upper part of the post, and in some cases is horizontal, but more frequently at an angle to the horizon; and the stay is that piece which supports the jib, reaching from the lower part of the post to nearly the extremity of the jib.

The most simple form of the crane is that commonly used in stone and timber wharfs for unloading vessels, for which purpose it is well adapted, its power being very great. It has a frame consisting of a strong beam supported horizontally at 10 or 12 feet from the ground, on the top of several vertical posts very firmly fixed in the ground, and securely braced with stays in every direction. At the extremity of the horizontal beam the upper part of the jib is supported, the lower pivot resting on a post in the ground. The jib, or gibbet, as it is called, from a resemblance to that machine, is a triangular frame of wood, one side being perpendicular, and supported on pivots at the top and bottom, so that the whole moves round on these as a vertical axis of motion. Near the upper end of the perpendicular post, a beam proceeds, forming the upper side of a triangle, while the third side is a brace, extended from the foot of the perpendicular, to support the upper piece. From the extremity of the latter, the burden is suspended by a rope passing over a pulley; the other end of the rope is coiled round a vertical roller, or capstan, turning on pivots, one supported by the horizontal beam first mentioned, and the other on a post in the ground. The capstan is turned round by means of long horizontal levers fixed to it, at which a great number of men may be employed to push them round, or, in some cases, they are drawn by horses. As the levers admit of a very great length in proportion to the diameter of the windlass on which the rope coils, the power of this simple crane is very considerable, and may be doubled by a pair of blocks or pullies at the jib. When the burden is raised to a sufficient height, by turning the capstan, the jib, being swung round on its pivots, will convey the load into a cart or waggon placed on shore by the side of the crane.

Another kind of crane, which is equally common with the above, but used for lighter burdens, has the same jibs, as indeed most cranes have; but the windlass, or barrel for the rope, is placed horizontally, and has a large vertical wheel fixed upon it. This is made of two wheels fixed on an axis at a distance apart, and united by boards, so as to form a large hollow cylinder or drum. Several men get into this wheel, and by constantly walking upwards on the inside, give it a tendency to revolve, and wind up the rope on the barrel. It is surprising, that so imperfect, this should have been so universally adopted as it was, till within these few years. Even when the wheel is sixteen feet in diameter, the laborers within cannot walk so far up it, from the perpendicular, as to have any effective leverage to turn it round; though they are always exposed to danger, and frequently meet with the most shocking and fatal accidents, from slipping down in the wheel, or from being overpowered by the load; in this case, the wheel runs back with an accelerating velocity, and the people are thrown about it in a most dreadful manner. From these defects of the common construction, skilful mechanicians have devised cranes that are not only more safe, but more powerful in their operation than the common walking crane. Some of these will be described in the present article.

A crane is to be considered as if consisting of two distinct parts:—that which communicates motion to the rope or chain, to which the weight is attached, and that which enables the force to act in any required position or convenient distance. It will be seen, by the consideration of the next crane, that we shall describe that the latter part is not always necessary, especially when the only object is to drag the weight towards it.

Fig. 1. Represents the *cellar* or *portable* crane. One side of it only is shown, the other side having the same framework, and a similar handle and winch; the wheels only being omitted. A B is the iron framed side; B, the handle turns the wheel C, which works in the large wheel D. Around the axis E, of the large wheel, one end of the rope is coiled; the other end holds the weight to be raised. The action is so simple that it is not necessary to describe it, except to remind the reader that the power will be in proportion to the size of the two wheels. Thus, if two men apply together the power of a hundred weight to the winches, and the small wheel attached to their spindle be of six teeth, while the large wheel has sixty teeth, they would be able to raise ten hundred weight—that is, supposing the drum or axle, round which the rope coils, be equal to the diameter of the large wheel, but if this be of one quarter the size of the large wheel, a further advantage of four to one is gained, and the two men would be able to raise two tons or forty hundred weight. If a greater power be required, the large wheel may have attached to it a small one of six teeth, and if this work a third wheel of sixty teeth, the rope being attached to the spindle of the last; the power would be increased tenfold, though the

time required to raise the weight would be in the same proportion longer.

Many other constructions of wheel-work are in common use for cranes. When they are turned by a winch it is proper to apply a fly wheel to the end of it, as is represented in fig. 2, both to equalize the efforts of the laborers who turn it, and in case he accidentally lets go the handle, to prevent the load from running down so quickly as to endanger anything.

The crane, fig. 2, is adapted not merely to lift up great weights, but, by having a lateral motion around a centre, it is capable of depositing them on the wharf, at a certain distance on either side of it, as may be required. A is a strong iron pillar which supports the whole of the crane above it. This revolves in a hollow chamber below the ground, resting partly on a pivot below, and partly on a broad collar and friction ball at B. CC is the jib, formed of wood or iron; E is the handle and small wheel, which works the large wheel that bears the drum for the rope; F is a fly wheel attached to the winch; G is a break—that is, a strap of iron, which, being pressed close to the fly wheel by holding the handle, occasions a sufficient friction when the goods are lowered; H and I are guide wheels or pullies for the rope to work in.

Mr. Bramah's ingenious hydrostatic principle of gaining a great power is applicable in several ways to the raising of heavy weights, and has been frequently employed in powerful cranes. In these the power is not obtained by wheel-work, pullies, or any other ordinary mechanical powers, but on the principle of the experiment called the hydrostatic paradox, which has been known for ages; but the application of its powers to useful purposes is due to Mr. Bramah.

The simplest form is, for a machine to raise a heavy weight to a small height. A metallic cylinder, sufficiently strong, and bored truly cylindrical within, has a solid piston fitted into it, which is made perfectly water-tight, by leather packing round its edge, or other means used in hydraulic engines. The bottom of the cylinder must be made sufficiently strong with the other parts of the surface, to resist the greatest strain which can ever be applied to it. In the bottom of the cylinder is inserted the end of the small tube, the aperture of which communicates with the inside of the cylinder, and introduces water or fluids into it; the other end of the pipe communicates with a small forcing-pump, by which the water can be injected into the cylinder beneath its piston; the pump has, of course, valves to prevent the return of the water. Now, suppose the diameter of the cylinder to be six inches, and the diameter of the piston of the small pump, or injector, only one-quarter of an inch, the proportions between the two surfaces or ends of the said pistons will be as the squares of their diameters, which are as 1 to 24; therefore, the areas will be as 1 to 576; and supposing the intermediate space between them to be filled with water, or any other dense and incompressible fluid, any force applied to the small piston will operate on the other in the above proportion of 1 to 576.—Suppose the small piston, or injector, to be forced down, when in the act of forcing or injecting, with a weight of 20 cwt., which can easily be done by means of a long lever, the piston of the great cylinder would then be moved up with a force equal to 1 ton multiplied by 576.

Fig. 3 represents a crane constructed upon the hydrostatical principle, that is, by the injection of water from a small pump into a large cylinder, which is fitted with a piston, having a rack attached to it, for the purpose of turning a pinion upon the axis of a large drum-wheel or barrel, round which the rope is coiled, and from thence passes to the jib

The figure AA represents the jib, made of iron, and supported upon two brackets, projecting from the wall of the warehouse in which the crane is supposed to be erected. The rope passes over the pulley I, and down through holes in the brackets, then turns under the pulley L, and comes to the lower side of the great drum-wheel B. The pinion C is fixed on the same axis with this, and its gudgeons turn in small iron frames, bolted down to the floor of the warehouse. The pinion C is actuated by the teeth of the rack D, and a small roller presses against the back of the rack, to keep its teeth up to the pinion. The rack is attached to the piston D of the cylinder, in which the power for working the crane is obtained. The piston passes through a tight collar of leather, on the top of the cylinder at E, which does not admit of any leakage by the side of it, and therefore if any water is forced into the cylinder, it must protrude the piston from it. The cylinder is supported in a wooden frame FF, and has a small copper pipe proceeding from the lower end of it, communicating with a small forcing-pump at H; this stands in an iron cistern, which contains the water, and sustains the standard, for the centre of the handle G, with which the pump is worked by one or two men. The upper extremity of the standard guides the piston-rod of the pump, to confine it to a vertical motion; and there is a weight for counterbalancing the handle G of the pump. From what we have said before, the operation of this machine is evident; the power of the cylinder D is, in proportion to its size, compared with the size of the pump; but, as it only acts through short limits, the pinion and drum B are necessary to raise the weight a sufficient height.

STEEL PLATES FOR ENGRAVING.

For several years past sheet steel has been used in large quantities, instead of copper-plates, by the engravers. By this fortunate application of so durable and, it may be added, so economical a material, not only has a new field been discovered, admirably suited to yield in perfection the richest and finest graphic productions which the ingenuity of modern art can accomplish, but to do so through an amazingly numerous series of impressions, without perceptible deterioration. The art of engraving on iron or steel, for purposes of ornament, and even for printing in certain cases, is by no means a discovery of modern times; but the substitution of the latter material for copper, which has invited the superiority of the British burin to achievements hitherto unattempted by our artists, is entirely a modern practice.

In the year 1810, Mr. Dyer, an American merchant, residing in London, obtained a patent "for certain improvements in the construction and method of using plates and presses, &c.," the principles of which were communicated to him by a foreigner residing abroad. This foreigner was Mr. Jacob Perkins, an ingenious artist of New England, and whose name subsequently became so extensively known in this country, in connection with roller-press printing from hardened steel plates.—The plates used by Mr. Perkins were, on the average, about five-eighths of an inch thick; they were either of steel, so tempered as to admit of the operation of the graver, or, as was more generally the case, of steel decarbonated, so as to become very pure soft iron, in which case, after they had received the work on the surface, they were case-hardened by cementation.

The decarbonating process was performed by inclosing the plate of cast steel, properly shaped, in a cast-iron box or case, filled about the plate to the thickness of about an inch, with oxyde of iron, or rusty iron filings. In this state the box is luted close, and placed in a regular fire, where it is kept at a red heat during from three to twelve days.—Generally about nine days are sufficient to decarbonise a plate five-eighths of an inch in thickness. When the engraving or etching has been executed, the plate is superficially converted into steel, by placing it in a box, as before, and surrounding it on all sides with a powder, made of equal parts of burned bones and the cinders of burned animal matter, such as old shoes, or leather. In this state the box with its contents, closely luted, must be exposed to a blood-red heat for three hours;—after which, it is taken out of the fire and plunged perpendicularly edgewise into cold water (which has been previously boiled to throw off the air); by this means the plate becomes hardened, without the danger of warping or cracking. It is then tempered or let down, by brightening the under surface of the plate with a bit of stone; after which it is heated, by being placed upon a piece of hot iron, or melted lead, until the rubbed portion acquires a pale straw color. For this purpose, however, the patentee expressed himself in favor of a bath of oil, heated to the temperature of 460°, or thereabouts, of Fahrenheit's scale. The plate being cooled in water, and polished on the surface, was ready for use.

In 1824, the large gold medal of the Society for the Encouragement of Arts and Manufactures, was presented to Mr. Charles Warren, for the communication of a paper on improvements in the art of engraving on steel. The death of Mr. Warren, in the interval, between the adjudication of the medal and the day of annual distribution of rewards having prevented the society from receiving such details as were expected from the inventor himself, the committee drew up a report on the subject, from which, along with details communicated by Mr. Phelps, and others of Mr. Warren's personal friends, the account published in the Society's Transactions was compiled. From this authentic source most of the following particulars are derived:—

Some of the earliest specimens of engraving on steel, for the purpose of printing, were produced by Albert Durer. There are four plates etched by this artist, impressions of which exist in the British Museum, which, in all books treating on the subject, are recorded as having been executed in steel; of these, one has the date 1510 inscribed on it. Since that time attempts have been made occasionally to employ steel instead of copper, as a material to engrave upon, but apparently with little success, on account, principally, of the great hardness of the material, which in a short time blunted and destroyed the tools which were made use of.

Steel, as is well known, exists commonly in two states, the elastic and the brittle, the former being considerably softer than the latter; of the elastic steel, a saw-blade may be considered as an example, and, in fact, pieces of saw-blade were the material upon which nearly all the earlier attempts have been made of late years, to revive a practice which, if successful, offered so many advantages to the artist and to the public. Mr. Raimbach, a few years ago, executed an engraving on a block or thick plate of steel, but met with so many difficulties in the execution, that his experiment remained insulated, and produced no sensible effect on the art of engraving.

Mr. Warren, in his early youth, was much employed in engraving on metals, for the use of calico printers and gunsmiths; and the experience thus acquired, induced him afterwards to turn his attention to the subject, with a view of applying it to the fine arts. It was suggested to him by Mr. Gill, one of the chairmen of the committee of mechanics, that the method employed by the artificers of Birmingham in the manufacture of ornamental snuffers and other articles of like description, is, to subject the cast steel, after having been rolled into sheets, to the process of decarbonisation, by means of which it is converted to a very pure soft iron; being then made into the required instrument, or other article, the ornamented work is engraved or impressed on the soft metallic surface; after which, by cementation with the proper materials, it is case-hardened, or again converted, superficially, to steel, and thus rendered capable of acquiring the highest polish.

In the attempt, however, to apply this process to plates for the engravers' use, two opposite difficulties occurred: a plate of steel, of the same thickness as that of common copper-plate, when thoroughly decarbonised, and thus reduced to the state of very soft iron, yields readily to the graver and other tools, and, especially, is susceptible of the process of *knocking-up;* this consists in scraping out any error with the graving tool, and afterwards striking the underside of the plate with a punch and hammer, in order to raise the cavity to the general level, and thus allow the artist to take the error out without occasioning any unevenness of the engraved surface; it was found, however, that plates of the thinness requisite for this operation, and of the usual superficial dimensions, were very liable to warp in the last or re-carbonising process, and were thus incapable of giving perfect impressions. If, in order to avoid this disadvantage, blocks, or plates, three or four times the ordinary thickness, were made use of, the warping indeed was prevented, but at the same time the process of knocking-up became impracticable, and it was necessary, in order to remove any error or defective part, to grind out the surface, or to drill a hole from the under surface almost through the plate, and then, by forcing in a screw, to raise that part of the face which was immediately above it. This latter process, however, was so tedious and difficult, as exceedingly to detract from the advantage of substituting steel for copper.

In this state of things it became a very interesting object of inquiry, to ascertain how many impressions might be taken from a plate of soft or decarbonised steel; and it was found that such a plate, prepared according to Mr. Warren's process, was capable of affording several thousand copies, without undergoing any sensible wear. In proof of this, the committee of the Society of Arts, &c. state, that impressions were laid before them by Mr. Warren, from two plates of decarbonised steel executed by him, the one for an edition of Mackenzie's works, published by Cadell, the other for an edition of Beattie and Collins, published by Rivington. These plates exhibited, both in the landscape and in the figures, the most elaborate and delicate work; five thousand impressions had been taken from one, and four thousand from the other; and yet between one of the first and one of the last impressions it was impossible to perceive any difference.

If Mr. Warren had carried on his experiments alone, working by himself till he had brought his plan to perfection, it is probable that, at the period of his death, the evidence of the great importance of his discovery would by no means have been so complete as it actually was; and the result of his exertions might have been lost, to the great detriment of the profession, and of the fair fame of this eminent artist. But selfishness and secrecy in any thing which related to the improvement of the art to which he was attached formed no part of his character; and all his discoveries, both those relating to the preparation of his plates, as well as those which had reference to the engraving upon them, were unreservedly and gratuitously communicated. The consequence of this liberality was, that besides the plates of Mr. Warren's own engraving produced before the committee above mentioned, impressions of portraits and other subjects engraved on decarbonised steel were shown, demonstrating that 8000, 20,000, and even 25,000 impressions had been taken off steel plates, before their respective artists had used them for the production of their own proofs.

Mr. Warren's original process for decarbonising the steel plates consisted in procuring a box or case of iron, and covering the bottom of it with a mixture of iron turnings and pounded oyster-shells; on this a steel plate is laid; another bed of the mixture is then added, and so on alternately, till the box is full, taking care that a bed of the composition should form the upper as well as the lower layer. The box so charged was then placed in a furnace, and kept for several hours at the highest heat which it would bear without melting; after which, being allowed to cool gradually, the plates were found to be reduced, for the most part, to the state of soft decarbonised steel.

Mr. Hughes, a copper-plate maker,* having been instructed by Mr. Warren in his process, and finding that the steel did not always turn out sufficiently and uniformly soft, (particularly for the purpose of engravers in mezzotinto,) imagined that those occasional defects were owing to a deficiency of heat in the cementing process; accordingly, he substituted a case or oven of refractory clay, for the cast-iron one, and then applying a considerably higher heat than the cast-iron box would have endured without melting, was enabled to obtain plates so soft that they might be bent over the knee.

Concerning the great superiority of steel-plate over copper-plate, for all works that require a considerable number of impressions to be taken, there can exist no doubt: for though the use of the graver, and of the other tools, requires more time on steel than on copper, and though the process of re-biting has not yet been carried to the degree of perfection in the former that it has been in the latter, yet the texture of steel is such, as to admit of more delicate work than copper; and the finest and most elaborate exertions of the art, which on copper would soon wear, so as to reduce them to an indistinct smeary tint, appear to undergo scarcely any deterioration on steel; even the marks of the burnishes are still distinguishable after several thousand impressions.

ENCAUSTIC PAINTING.

The art of painting in encaustic is a manner of painting which is executed with the operation of fire. Ancient authors often make mention of this species of painting, and which, if it had been described simply by the word *encaustic*, which signifies executed by fire, might be supposed to have been a species of enamel painting. But the expressions *encausto, pingere, pictura, encausticâ, ceris pingere, picturam, inurere*, by Pliny, and other ancient writers, makes it clear another species of painting is thereby meant. We have no ancient pictures of this description, and, therefore, the precise manner adopted by the ancients is not completely developed, though many moderns have closely investigated the subject, and described their processes. At what time, and by whom this species of painting was first invented, is not determined by antiquaries, although it appears to have been practised in the fourth and fifth centuries. Count Caylus, and M. Bachelier, a painter, were the first of modern times who made experiments in this branch of art, about the year 1749. Some years after this, Count Caylus presented to the Academy of Painting, at Paris, his ideas and experiments on the subject of the ancient manner of painting in encaustic. In 1754, the count had a head of Minerva painted by Mons. Vien, after the process described by himself, and presented it to the Academy of Sciences in 1755. This success induced Mons. Bachelier to recommence his experiments, in which he succeeded better than formerly; but his manner of painting in encaustic differed from the ancients, as described by Pliny, and, therefore, he was unsuccessful, inasmuch as he did not discover the *real* ancient manner; after this he made some other experiments on the same subject, differing from the process as described by Caylus and others.

Pliny, in a passage relating to encaustic painting, distinguishes three species:—First—that in which they used a style, and painted on ivory or polished wood *(cestro in ebore)*; for which purpose they drew the outlines on a piece of the aforesaid wood or ivory, previously soaked or imbued with some certain color; the point of the style or stigma served for this operation, and the broad end to scrape off the small filaments that arose from the outlines, and they continued forming outlines with the point till they were finished. Second—The next number appears to have been, where the wax previously impregnated with color was spread over the surface of the picture with the style, and the colors thus prepared were formed into small cylinders for use. By the side of the painter was a brazier for keeping the styles continually hot, with the points of which they laid on the colors when the outlines were finished, and spread them smooth with the broad end, and thus they proceeded till the picture was finished. Third—The manner was by painting with a pencil in wax liquified by fire; by this method the colors contained a considerable hardness, and could not be damaged either by the heat of the sun or the deleterious effects of the sea water. It was thus that they painted their ships with emblems and other pictures, and, therefore, it obtained the name of *ship painting*. The last process was to smooth and polish the picture;—thus far the ancients.

Few, of late years, have made more experiments in this mode of painting than the ingenious Mrs. Hooker, of Rottingdean, in the county of Sussex, who has, in this instance, united practice with theory; and for her very successful exertions in this branch of the polite arts, was presented with a gold palette by the Society for the Encouragement of Arts, &c. of London. Her account is printed in the 10th volume of the Society's Transactions for the year 1792, when Miss Emma Jane Greenland. Her first communication with specimens of this mode of painting was made in the year 1786, one of which is preserved in the society's rooms at the Adelphi, and is worth the attention of the artist.—This honorable testimony of the society's approbation did not occasion any relaxation in this indefatigable lady's endeavour to attain excellence, and she, therefore, in the year 1807, made a farther communication to the Society of the result of no less than fifty experiments per day, during more than four months; and to theory, Mrs. Hooker has added much practical knowledge, having painted several pictures very successfully. The following account combines the results of this lady's two communications to the society, which, in honor to her extraordinary merits and exertions in this curious branch of the fine arts, should be called the *Hookerian* mode of encaustic painting.

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* Now living in Shoe Lane, London, where every article required by the engraver may be purchased, and of excellent quality.

Method of preparing and applying a composition for painting, in imitation of the ancient Grecian manner, as practised by Mrs. Hooker.

Put into a glazed earthen vessel four ounces and a half of gum arabic, and eight ounces or half a pint (wine measure) of cold spring water: when the gum is dissolved, stir in seven ounces of gum mastich, which has been washed, dried, picked, and beaten fine. Set the earthen vessel containing the gum mastich over a slow fire, continually stirring and beating them hard with a spoon, in order to dissolve the gum mastich: when sufficiently boiled it will no longer appear transparent, but will become opaque and stiff like a paste. As soon as this is the case, and the gum, water, and mastich are quite boiling, without taking them off the fire, add five ounces of white wax, broken into small pieces, stirring and beating the different ingredients together till the wax is perfectly melted and has boiled; then take the composition off the fire, as boiling it longer than necessary would harden the wax, and prevent it mixing so well afterwards with water. When the composition is taken off the fire, and in the glazed earthen vessel, it should be beaten hard, and whilst hot (but not boiling) mix with it by degrees a pint, or sixteen ounces more of cold spring water; then strain the composition, as some dirt will boil out of the gum mastich, and put it into bottles. The composition, if properly made, should be like a cream, and the colors, when mixed with it, as smooth as with oil. The method of using it is to mix with the composition, upon an earthen palette, such colors in powder as are used in painting with oil, and such a quantity of the composition to be mixed with the colors as to render them of the usual consistency of oil colors; then paint with fair water.

The colors, when mixed with the composition, may be laid on either thick or thin, as best suits your subject, on which account this composition is very advantageous where any particular transparency of coloring is required; but, in most cases, it answers best, if the colors are laid on thick, as they require the same use of the brush as if painting with body colors, and the same brushes as used in oil painting. The colors, if grown dry when mixed with the composition, may be used by putting a lit[illegible] water over them; but it is less trouble to put some water when the colors are observed to be growing dry. In painting with this composition the colors blend without difficulty when wet, and even when dry the tints may easily be united by means of a brush and a very small quantity of water. When the painting is finished, put some white wax into a glazed earthen vessel over a slow fire, and when melted, but not boiling, with a hard brush cover the painting with the wax, and when cold take a moderately hot iron, such as is used for ironing linen, and so cold as not to hiss if touched with anything wet, and draw it lightly over the wax. The painting will appear as if under a cloud till the wax and whatever substance the picture is painted upon are perfectly cold; but if when so, the painting should not appear sufficiently clear, it may be held before the fire at such a distance as to melt the wax slowly; or the wax may be melted by holding a hot poker at such a distance as to melt it gently, especially over such parts of the picture as should not appear sufficiently transparent or brilliant: for the oftener heat is applied to the picture the greater will be the transparency and brilliancy of coloring; but the contrary effect would be produced if too sudden or too great a degree of heat is applied, or for too long a time, as it will draw the wax too much to the surface, and may likewise crack the paint. Should the coat of wax put over the painting when finished appear in any part uneven, it may be remedied by drawing a moderately hot iron over it again, as before mentioned, or even by scraping the wax with a knife; and should the wax, by too great or too long an application of heat, form into bubbles at particular places, by applying a poker heated, or even a tobacco-pipe made hot, the bubbles will subside; or such defects may be removed by drawing anything hard over the wax, which will close any small cavities. When the picture is cold, rub it with a fine linen cloth. Paintings may be executed in this manner upon wood (having first pieces of wood let in behind, across the grain of the wood, to prevent its warping), canvass, card, or plaster of Paris. The plaster of Paris requires no other preparation than mixing some fine plaster of Paris in powder with cold water, the thickness of a cream: then put it on a looking-glass, having first made a frame of bees wax on the looking-glass, the form and thickness of which you wish the plaster of Paris to be, and when dry take it off, and there will be a very smooth surface to paint upon. Wood and canvass are best covered with some gay tint mixed with the same composition of gum arabic, gum mastich, and wax, and of the same sort of colors as before mentioned, before the design is begun, in order to cover the grain of the wood or the threads of the canvass. Painting also may be done in the same manner with only gum water and gum mastich, prepared the same way as the mastich and wax; but instead of putting seven ounces of mastich, and, when boiling, adding five ounces of wax, mix twelve ounces of gum mastich with the gum water, prepared as mentioned in the first part of this receipt; before it is put on the fire, and when sufficiently boiled and beaten, and is a little cold, stir in, by degrees, twelve ounces, or three quarters of a pint (wine measure) of cold spring water, and afterwards strain it. It would be equally practicable to paint with wax alone, dissolved in gum water in the following manner. Take twelve ounces, or three quarters of a pint (wine measure) of cold spring water, and four ounces and a half of gum arabic, put them into a glazed earthen vessel, and when the gum is dissolved, add eight ounces of white wax. Put the earthen vessel, with the gum water and wax, upon a slow fire, and stir them 'till the wax is dissolved and has boiled a few minutes; then take them off the fire, and throw them into a basin, as, by remaining in the hot earthen vessel, the wax would become rather hard; beat the gum water and wax till quite cold. As there is but a small proportion of water in comparison to the quantity of gum and wax, it would be necessary, in mixing this composition with the colors, to put also some fair water. Should the composition be so made as to occasion the ingredients to separate in the bottle, it will become equally serviceable if shaken before used to mix the colors.

Another very serviceable quality in the vehicle for painting was discovered by Mrs. Hooker, which was, that the composition which had remained in a bottle since the year 1792, in which time it had grown dry and become as solid a substance as wax, returned to a cream-like consistence, and became again in as proper a state to mix with colors as when it was first made, by putting a little cold water upon it, and suffering it to remain on a short time. "I also lately found," says this ingenious lady, "some of the mixture composed of only gum arabic, water, and gum mastich, of which I sent a specimen to the Society of Arts, in 1792; it was become dry, and had much the appearance and consistency of horn. I found, on letting some cold water remain over it, that it became as fit for painting with as when the composition was first prepared."

(To be continued)

ON THE PRESERVATION OF MEAT FOR FOOD.

BY M. GANNAL.

THE following is a translation of an abstract of a memoir read before the Royal Academy of Sciences, Paris, by M. Gannal, inventor of the well-known process of embalming, as given in the *Compte Rendu* of March 22. The author commenced by recapitulating some of the inconveniences presented by the most commonly employed processes for preserving meat; he remarked that, whatever substance he employed, great advantages result from its being introduced by injection, instead of making it slowly penetrate, as in the ordinary process of salting, by imbibition from within or without.

"By injection will be obtained, besides the saving of time and money, an uniform distribution of the preservative substance, while by maceration, especially if large pieces be acted on, the portions nearest to the outside, become super-saturated with that substance, before the internal parts have received sufficient to prevent their decomposition."

Then, devoting himself to the examination of the substances which might be used instead of common salt, M. Gannal referred to the soluble salts of alum, substances which have the power of preventing the putrid fermentation of animal matter, but some of which communicate to it an unpleasant taste, or injurious properties. According to him, none of these inconveniences exist in the chloride of aluminum.

"I was," said he, "theoretically convinced that flesh preserved by this salt in a state of purity, should acquire no taste, because, in the first place, the quantity used is very small, and besides, from the reaction which is operated, there results only a small quantity of chloride of potassium, sodium, or calcium—salts which are daily employed in our households, in the grey salt consumed in our kitchens. As for the portion of alumina introduced into and combined with the animal matter, it is met with in such small quantities that it need not be stopped.

"Alum is employed in medicine, and acts as an astringent; but, in this case, the argillaceous earth is combined with an acid, while in meat it is nothing more than an earthy powder, without action on the animal economy. On this subject, it may be affirmed that the inhabitants of the borders of the Seine, who drink the water of that river at least half the year, daily drink ten times more aluminous earth than they would take by habitually eating meat prepared by my process.

"Experiments on the degree of concentration to be given to my liquid to effect the preservation of meat, without uselessly adding too large a quantity of salt, have shown me that the suitable solution should mark 10° of Baume's Areometer. Now one kilogramme of this salt, as prepared by M. Guerin, is sufficient for six quarts of water: from nine to twelve quarts of this liquid are required for the preservation of an ox, that is to say, from one kilogramme and a half to two kilogrammes are employed.

"The *modus operandi* is very simple. When the animal is felled by a blow on the forehead, the carotid and the jugular are opened on one side, by making an incision from the larynx to those two vessels; then, by a brisk movement, the cutting instrument is raised, which divides all the parts, and allows the whole of the blood to run out.

"When the blood ceases to flow, a syphon is introduced into the carotid, a ligature is made at the superior part to prevent the liquid from running out, both the apertures of the jugular are tied, and the injection is then introduced.

"The most suitable instrument for this operation is a tube of waterproof linen, of two metres in length, three centimetres in diameter at the bottom, and five or six centimetres at the top; this tube must be fixed to the syphon, which should be of wood or horn.

"As soon as it is perceived that the animal is well injected, that is to say, when no more liquid goes in, and when the subcutaneous veins are well swelled, the tube must be squeezed between the finger and thumb, which must be made to descend with pressure for the length of the column; by this means the quantity of the liquid is increased in the interior of the animal. A ligature is made below the syphon, which is then withdrawn; twenty minutes afterwards the animal is skinned, then emptied, and, finally, cut up in the ordinary way; there is no necessity for removing the bones and fat, as in the process of salting.

"When the animal has been well bled, and the injection well performed, it is scarcely perceptible that the animal has undergone any preparation at all. The only part where the injection leaves traces is in the lungs, which are dried up and discolored.

"When the animal is cut up and hung in the air, the flesh is left in this state until it is cold; the only precaution to be taken is to prevent the flies from getting at it.

"Meat which it is wished to preserve for a certain time, requires no other precaution; it is sufficient to hang it in a dry and airy place. When it is intended to preserve it more than fifteen days, the flesh must be washed in a solution at ten degrees of chloride of sodium, and an equal quantity of chloride of aluminum. When this is done, the meat is applied to the purposes for which it is intended. That which is to be dried, must be hung in a chamber heated by means of a current of hot air, or air charged with wood smoke, or even in the open air; but in this case, flies must be guarded against.

"When this meat is dried, it is sufficient to pack it in barrels hermetically sealed, and to keep the latter in a dry place.

"To use this meat, all that is required is to macerate it for four-and-twenty hours, and as it is not salted, the swelling may easily be effected in sea water.

"When it is wished to preserve fresh meat, it is piled up in barrels, as is done in the common method of salting; when the cask is full it is closed up; then it is filled with either a saturated solution of chloride of sodium, with the washing mixture, or simply with dry chloride of sodium. The three means have given good results.

"This bath contributes but little to the preservation, but it prevents the vegetation of *byssus;* without this precaution, the meat would become musty.

"Among the experiments which I made, a barrel was opened after three months, and a leg of mutton was taken out which was roasted and eaten, and pronounced very good by twelve persons; but the barrels having been badly closed the liquid of the bath was lost, and the meat was covered with mould, but was not decomposed."

A committee, consisting of MM. Thenard, Magendie, Dumas, and Séguier, has been appointed by the Academy to investigate the merits of this process, and to report thereon.

MEMORANDA.

Vegetation in Atmospheres of different Densities.—The following experiments have been made by Professor Dobereiner, of Jena:—Two glass vessels were procured, each of the capacity of 320 cubic inches, two portions of barley were sown in portions of the same earth, and moistened in the same degree, and then placed one in each vessel. The air was now exhausted in one, till reduced to the pressure of fourteen inches of mercury, and condensed in the other, until the pressure equalled fifty-six inches. Germination took place in both, nearly at the same time, and the leaflets appeared of the same green tint; but at the end of fifteen days the following differences existed:—The shoots in the rarefied air were six inches in length, and from nine to ten inches in the condensed air. The first were expanded and soft; the last rolled round the stem and solid. The first were wet on their surface, and especially towards the extremities; the last were nearly dry.

Sound.—The French academicians made, in 1738, some experiments for measuring the velocity of sound: the board of longitude renewed them in the month of June last, with all possible precision, when they found that the velocity of sound in the air, at the temperature of 55° Fahrenheit, differs very little from 1044 feet per second.

The Chick in Ovo.—Mr. David Ritchie says, he has heard of a mode of discovering the sex of the chick in the egg, differing from any which have been proposed by naturalists. The folliculus aeris, or air-cell, which is to furnish oxygen to the future chick, is situated at the larger end of the egg. It has not in all eggs the same position at the larger end; and in various districts of Scotland, it is believed that eggs bearing the air-cell only near the top of the larger end produce females. To ascertain this Mr. R. instituted a series of experiments. These experiments go very far to prove that the opinion which has been stated is correct, and so to determine what naturalists of Germany, France, and England, have endeavoured in vain to discover.

Changes of the Kaleidoscope.—Supposing the instrument to contain twenty small pieces of glass, &c., and that you make ten changes in each minute, it will take the inconceivable space of 462,880,899,576 years and 360 days to go through the immense variety of changes it is capable of producing, amounting (according to our frail idea of the nature of things) to an eternity. Or, if you take only twelve small pieces, and make ten changes in each minute, it will then require 33,264 days, or 91 years and 49 days to exhaust its variations.

Weight of the National Debt of England, in £10 Bank Notes.—One hundred men could not carry the national debt of England in ten pound notes, 512 of which weigh a pound; so that 242 millions of pounds sterling (which was the amount of the national debt in 1770, when this calculation was made) would weigh 47,650 pounds, which, for a hundred men, would be 437 pounds each.

Curious Experiment with a Tulip.—The bulb of a tulip, in every respect, resembles a bud, except in its being produced under ground, and includes the leaves and flower in miniature, which are to be expanded in the ensuing spring. By cautiously cutting in the early spring, through the concentric coats of a tulip root, longitudinally from the top to the base, and taking them off successively, the whole flower of the next summer's tulip is beautifully seen by the naked eye, with its petals, pistil and stamina.

The Travelling of Light.—Light travels at the rate of an hundred and fifty thousand miles in a single second; and it is seven minutes in passing from the sun to the earth, which is nearly a distance of seventy millions of miles! Such is the rapidity with which these rays dart themselves forward, that a journey they perform thus in less than eight minutes, a ball from the mouth of a cannon would not complete in several weeks! But the minuteness of the particles of light are still several degrees beyond their velocity; and they are, therefore, harmless, because so very small. A ray of light is nothing more than a constant stream of minute parts, still flowing from the luminary, so inconceivably little, that a candle, in a single second of time, has been said to diffuse several hundreds of millions more particles of light, than there could be grains in the whole earth, if it were entirely one heap of sand.—The sun furnishes them, and the stars also, without appearing in the least to consume, by granting us the supply; its light is diffused in a wide sphere, and seems inexhaustible.

To produce Fire from Cane.—The Chinese rattan, which is used, when split, for the making of cane chairs, will, when dry, if struck against each other, give fire; and are used accordingly in some places, in lieu of flint and steel.

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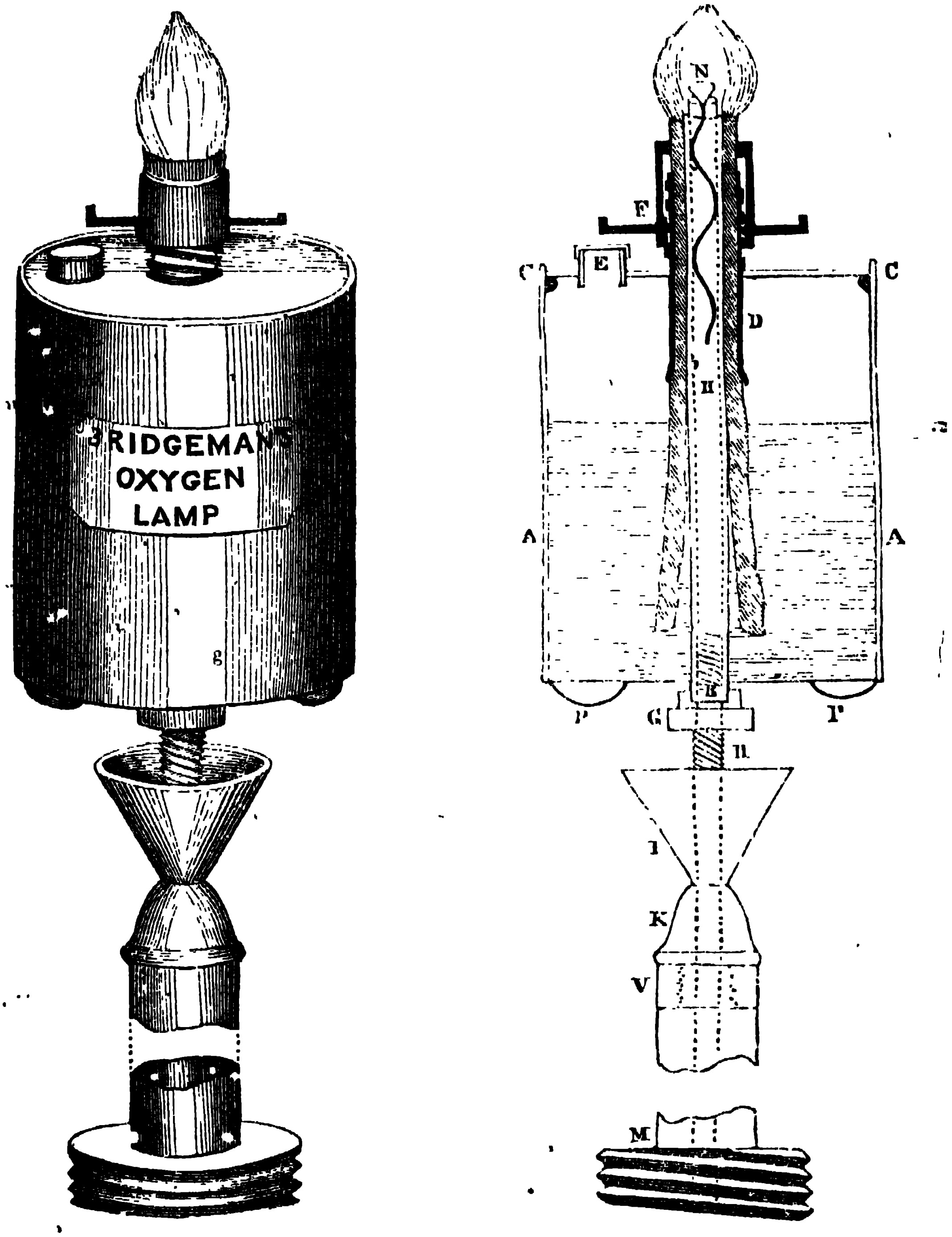


BRIDGEMAN'S OXYGEN LAMP.

BRIDGEMAN'S OXYGEN LAMP.

To the Editor.

Sir.—Being engaged in the early part of the winter of 1839, with a scientific gentleman of this town, Mr. Edward Mugridge, in experimenting with a magic lanthorn, and endeavouring to obtain a better light than was given by the common lamps, usually sold with them; the idea was suggested by the latter gentleman, of supplying the flame with oxygen gas; the attempt was made, but did not answer in the way we tried it. I then turned my attention to it more minutely, and, after a long course of experiments, succeeded beyond my most sanguine expectations; my idea was, that it might be obtained by filling the interior of the flame of a common candle, or small lamp, with oxygen gas, which has proved correct. The gas is passed through a *large aperture*, with but *little pressure*, and produces a light, both steady and perfectly under control. I have had one burning for three or four hours at a time (with a light scarcely to be borne by the naked eye, without requiring to be even touched), and am convinced, by my own experience, and the opinion of a first-rate London optician, whose judgment may be relied on (and who, when he reads this, will see the original of a piracy), that the invention will be of great benefit to the optical world, and particularly as its construction is so simple that any one, possessing a moderate share of mechanical talent, may construct one for himself, and on that account I have been more particular in giving the minutiæ of what I have found to answer best and most simple in construction, and have given the drawing the exact size.

A is of tin, with the brass tube B soldered to the bottom, and projecting about ¼ of an inch below it. C is a circular brass lid, with the tubes D and E soldered in it, and resting on a wire soldered round the inside of A. F is a brass ferrule with one of the three pins acting on the screw cut on the outside of D. G is a brass nut tapped to fit the screw on the tube H, and locking into the niche on the lower end of the tube B. H is the brass tube through which the gas is passed to the flame. I is a tin cup *soldered* on the tube H to catch the overflowing oil. K is a nut to fasten the tube into the end of the tube V, the lower end of which is soldered to the small screw of a common union joint M, which allows it to be attached by a flexible tube either to a gasometer or gas bag.

The wick is made of the common flat cotton, the two sides being sewn together and placed loosely on the tube B; it is then cut off level with it, and opened from the tube a little. The inner tube H is about 1-16th of an inch smaller than B, which holds it in the centre by three points, filed on its end and bent towards the centre; thus allowing the overflowing oil to pass down between the tubes into the tin cup I; the gas is thrown obliquely into the flame, by the small inverted platina cone N, which is attached to a fine wire, bent so that it may be pushed gently into the tube, and remain where it is placed. The tube L serves to support the lamp by being fixed in a spring socket, and the lamp resting on the nut G, the end of the gas tube may be adjusted to a great nicety in the flame, by merely turning the lamp round a practical point to be attended to. Another great advantage of this form of lamp is, that it may, in a moment, be taken off and used as a common lamp for carrying about, and, although the tube B is open, the air does not pass up it so as to give it the form of an Argand flame. When taken off, the ferrule F should be turned up till it does not smoke, and by means of that it may be made a light of any power, either consuming a cubic foot of gas per hour, or reducing it to one-fourth that quantity, regulating the gas to the size of the flame. The three nobs P serve as feet to prevent the lower end of the tube B being injured, and the opening E is for allowing it to be filled with oil without removing the lid, which is only required when a new wick is put in.

King's Lynn, W. K. BRIDGEMAN.
May 10th, 1841. *Dispensing Chemist.*

ENCAUSTIC PAINTING.

(Resumed from page 63, and concluded.)

J. C. Werner, of Newstadt, in Germany, found the following process very effectual in making wax soluble in water:—For each pound of white wax he takes twenty-four ounces of potash, which he dissolves in two pints of water, warming it gently. In this ley he boils the wax, cut into little bits, for half an hour; at the end of this time he takes it from the fire and lets it cool. The wax fixes itself at the surface of the liquor in the form of a white saponaceous matter, which being triturated with water, produces a sort of emulsion which he called wax milk, or encaustic wax, and may be applied to pictures, furniture, or leather, after having well cleaned them: in an hour after the application the article should be rubbed with a piece of woollen cloth, which will cause the pictures to have a better effect, and the furniture to acquire a peculiar brightness. Another advantage of this preparation of wax is, that it can be mixed with all kinds of colors, and consequently be applied in a single operation. It is also useful to fix water colors.

The following important observations are translated from the Italian of the Chevalier Lorgna, who has deeply investigated the subject, in a small but valuable tract, called "*Un Discorso sulla Cera Punica.*" The ancients (says this author,) according to Pliny, used three species of painting, and in all three they used fire; so that to paint with encaustic, or with a burning application, (abbrucciamento,) is derived from a Greek word.

We have never thoroughly known the nature of the Punic wax, which was anciently used, and which, after all, was the essential ingredient of the ancient painting in encaustic. The Chevalier praises the genius and industry of M. Requeno and M. Bachelier, who have also treated of this subject, but who have not fully succeeded in finding out the true way of making the said wax, then quotes the passage of Pliny on the method of making it. *Punica fit hoc modo,* &c., (see Pliny's Nat. History, l. 21, c. 14,) and asserts, with many other writers, that Pliny's *nitre* is not the *nitre* of the moderns, properly so called, but it is the *natron* of the ancients, viz. the native salt which is found crystallised in Egypt and other hot countries, in sands surrounding lakes of salt water; it must not be mistaken for the natron of the new nomenclature of our College of Physicians, which is the new name of the mineral alkali.

In the plains of Lower Egypt, which was once covered by the sea, in the environs of the salt lakes of that country, at Tripoli, at Tunis, as also in the adjacent parts of ancient Carthage, the *natron*, that same *natron* which, under the name of *nitre*, the Carthaginians, according to Pliny, used in preparing their wax, is to this day extracted, and hence it was called *Punic wax.*

I began now (says Lorgna,) successively to try my experiments, first with three parts of wax and one of natron, and then with four of wax, and so on till I used twenty parts of white melted wax with only one of natron, with as much water as was just sufficient to melt the natron. I held the mixture in an iron vessel over a slow fire, stirring it gently with a wooden spatula, till the two substances thickened by evaporation, and in closely uniting the mass, by degrees assumed the consistence of butter, and the color of milk. I removed it then from the fire, and put it in the shade to let it harden and to perfect itself in the open air. This natron was extracted from the ley of kali of Malta, evaporated till it was dry; it may also be extracted from the kali of Spain, Sicily, Sardinia, and from that of Tunis and of Tripoli, which may be procured without much difficulty. The wax being cooled, it liquefied in water, and a milky emulsion resulted from it like that which could be made with the best Venetian soap.

Pliny, in another place, c. 7, l. 23, gives further directions for the manner of using caustic on paintings on walls; but as it concerns the antiquary more than the artist, I have forborne from making the quotation It begins at these words, *Et parietis siccato cera Punica*, &c.

As to making use of this wax in painting in encaustic the Chevalier says, that magnificent and repeated experiments were made in the apartments of the Count Giovanni Battista Gasola, by the Italian painter Signor Antonio Paccheri. He dissolved the Punic wax, when it was not yet so much hardened as to require to be igne resoluta, as expressed by Pliny, with pure water, lightly infused with gum arabic, instead of sarcocolla, male incense, mentioned by Pliny. He afterwards melted and mixed his colors with this wax as liquefied as he would have done with oil, and proceeded to paint in the same manner; nor were the colors seen to run or alter in the least; and the mixture was so flexible that the pencil ran smoother with it than it would have done with oil. The painting being dry, he used the caustic over it, and rubbed it with linen cloths, by which the colors acquired a peculiar vivacity and brightness which they had not before the caustic and the rubbing had been effected.

SPOTS, MOUNTAINS, &c. IN THE MOON.

When the moon is viewed through a good telescope, her surface appears to be diversified with hills and valleys; but this is most discernable when she is observed a few nights after the change or opposition, for when she is either *horned* or *gibbous*, the edge about the confines of the illuminated part is jagged and uneven.

Many celebrated astronomers have delineated maps of the face of the moon; but the most celebrated are those of Hevelius, Grimaldi, Riccioli, and Cassini; in which the appearance of the moon is represented in its different states, from *new to full*, and *from full to new*.

The light or illuminated parts which appear upon the face of the moon are elevated tracts, some of which rise into very high mountains, while the dark parts appear to be perfectly smooth and level. This apparent smoothness in the faint parts, naturally led astronomers to conclude that they were immense collections of water; and the names given to them, by some celebrated astronomers, are founded on this supposition. For Hevelius distinguished them by giving them the names of the seas on the earth: while he distinguished the bright parts by the names of the countries and islands on the earth. But Riccioli and Langren distinguished both the dark and light spots, by giving them the names of celebrated astronomers and mathematicians, which is now the general manner of distinguishing them.

That the spots which are taken for mountains and valleys are really such, is evident from their *shadows*. For in all situations in which the moon is seen from the earth, the elevated parts are constantly found to cast a triangular shadow in a direction from the sun; and on the contrary, the cavities are always dark on the side next the sun, and illuminated on the opposite side, which is quite conformable to what we observe of hills and valleys on the earth. And as the tops of these mountains are considerably elevated above the other parts of the surface, they are often illuminated when they are at a considerable distance from the line which separates the enlightened from the unenlightened part of the disc, and by this means afford us a method of even determining their height.

Previous to the time of Dr. Herschel, some of the lunar mountains were considered to be double the height of any on the earth; but by the observations of that celebrated astronomer, their height is considerably reduced.

For after measuring many of the most conspicuous prominences, he says, "From these observations I believe it is evident, that the height of the lunar mountains is, in general, overrated; and that when we have excepted a few, the generality do not exceed half a mile in their perpendicular elevation."

As the moon's surface is diversified by mountains and valleys as well as the earth, some modern astronomers say they have discovered a still greater similarity; namely, that some of these are really volcanoes emitting fire, as those on the earth do. An appearance of this kind was discovered by Don Ulloa in an eclipse of the sun, which happened on the 24th June, 1778. It was a small bright spot like a star, near the margin of the moon, which he supposed at the time to be a hole or valley, which permitted the sun's light to shine through it. Succeeding observations have, however, led astronomers to believe, that appearances of this kind are occasioned by the eruption of volcanic fire. Dr. Herschel, in particular, has observed several eruptions of this kind, the last of which he has described in the Philosophical Transactions for 1787, as follows: "On April the 19th, at 10h. 6m. I perceived three volcanoes in different places of the dark part of the new moon. Two of them are either already nearly extinct, or otherwise in a state of going to break out, which perhaps may be decided next lunation. The third shows an actual eruption of fire or luminous matter: its light is much brighter than the nucleus of the comet which M. Mechain discovered at Paris, on the 10th of this month." The following night the Doctor found it burned with greater violence; and by measurement he found that the shining or burning matter must be more than three miles in diameter, of an irregular round figure, and very sharply defined about the edges. The other two volcanoes resembled large faint nebulæ, which appeared to be gradually brighter towards the middle, but no well-defined luminous spot could be discovered in them. Dr. Herschel adds, "The appearance of what I have called the actual fire, or eruption of a volcano, ex. That sembled a small piece of burning charcoal, either is covered by a very thin coat of white ashes, which frequently adhere to it when it has been some time ignited; and it had a degree of brightness about as strong as that with which a coal would be seen to glow in fair day light."

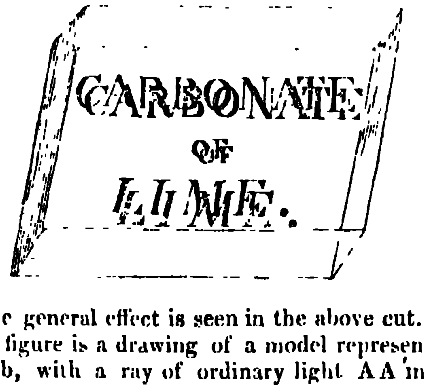
The appearance which Dr. Herschel here describes so minutely, was also observed at the Royal Observatory of Paris, about six days before, by Dominic Nouet, like a star of the sixth magnitude the brightness of which occasionally increased by flashes. Other astronomers also saw the same thing, for M. de Villeneuve observed it on the 22nd of May, 1787. This volcano is situated in the north-east part of the moon, about 3′ from her edge, towards the spot called Helicon. After considering all the circumstances respecting these appearances which have just been mentioned, we must subscribe to Dr. Herschel's opinion, that volcanoes exist in the moon as well as the earth.

(To be continued.)

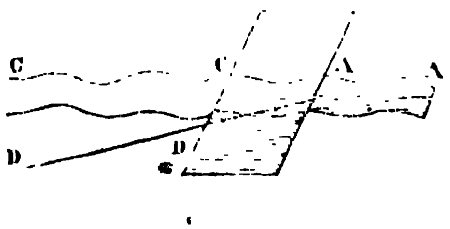
POLARIZATION OF LIGHT.

(Resumed from page 38.)

In the transmission of ordinary light through transparent or refracting bodies, perfectly homogeneous in their structure, and of a uniform temperature throughout, such as pure water, well annealed glass, and many kinds of crystallized bodies, as alum, common salt, Fluor spar, &c., a single beam will be refracted singly; and if we make a pin-hole in a card, and place it behind one of these bodies, and behind the card a candle, so that the light may first pass through the hole in the card, and then through the subject of experiment to the eye, the hole will be distinctly seen, and will be perfectly single. But in most crystalline substances this is not the case, for such usually possess the property of double refraction, a beam of light passing through any of them being refracted into two beams of equal intensity. This beautiful and interesting phenomenon is seen, in an eminent degree, in Iceland spar (calcareous spar), in which it was first discovered.


CARBONATE OF LIME.

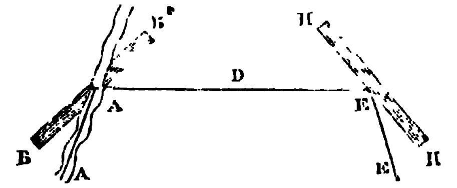
The general effect is seen in the above cut. The next figure is a drawing of a model representing a rhomb, with a ray of ordinary light AA incident upon one of its natural faces, and which, in passing through the crystal, is divided into two rays, one of which, CC, being refracted according to the ordinary way; the other, DD, not obeying the same law, but being refracted in an extraordinary manner,.is called the extraordinary ray,



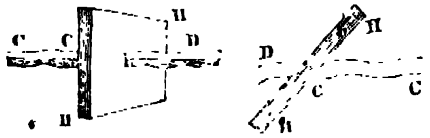
and,

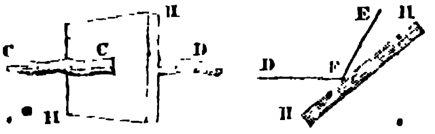
Now, on analysing these rays, either with a second rhomb, or otherwise, which will be better understood as we proceed, they are found to be precisely alike in every respect, of the same character, and possessing the same properties, but that these properties and characters are at right angles to each other; the doubly refracting action of the crystal upon light consisting in the separation of the two sets of undulations, or transversal vibrations, of which a ray of ordinary light consists; the vibrations of the ethereal molecule, in the ordinary ray, will be in one plane; while the vibrations of the ethereal molecules, in the extraordinary ray, will be in another plane, at right angles to it, as represented by the last figure; and, if we suppose this to be a bird's-eye view, the vibrations of CC will be in a horizontal plane, and the vibrations of DD in a perpendicular plane; each of which is said to be polarized light: hence, when the question is asked, what is the difference between common and polarized light? the reply, according to the undulatory theory, is, that a ray of ordinary or common light, whether artificial or solar, consists of two sets of undulations or vibrations of the molecules of the ethereal or imponderable medium, which we have supposed to fill all space; and that these two sets of undulations are performed in planes, at right angles to each other; but that polarized light consists of one set of undulations, or vibrations, performed in one plane. The polarization of light, then, is simply the separation of the two sets of undulations, or vibrations, of which ordinary light is composed, and thus producing a beam of light in which the vibrations of the ethereal molecules are all in one plane.

Now, this separation, or polarization (as it has rather improperly been called), may be effected with common crown glass, either by ordinary reflection or refraction, each of which will exhibit the same effects. In order to understand this, let BB represent a bundle of plates of common glass, placed so that a ray of ordinary light AA may form an angle of incidence of 56° 45′ with a line perpendicular to their surface; then the light reflected, and represented as passing off at D, will be polarized light; and if a proper number of plates, which, for the same angle of incidence, is 27, be employed, the light transmitted at E will be polarized also, the two rays possessing the same properties, but at right angles to each other. Thus, in the reflected ray, D, the vibrations are supposed to take place in a perpendicular plane, this being a bird's-eye view, whilst, in the refracted ray, E, the vibrations are performed in a horizontal plane. This will be easily understood on analyzing either of the rays, which may be done by the same means as that by which the original beam is polarized. Thus, supposing we experiment with, or analyse the reflected ray D, in which the vibrations are in a perpendicular plane, when it is made to fall upon a second bundle of glass HH, at the same angle of incidence, and the glass be so placed that the reflection may again be in the same plane, it will again be wholly reflected



as at EE, and none will be transmitted or refracted through the second bundle of glass, for the very same cause that produced its reflection from the first. bundle; viz. that the vibrations continue parallel to the reflecting surfaces. But if the second bundle of glass is put in such a position that the vibrations shall be performed in a plane perpendicular to the reflecting surface (which may be done" by turning it round 90°, in such a condition that the ray of light shall be the axis upon which it turns, and always making the same angle of incidence); then, as soon as it begins to turn, the reflected light will begin to decrease in intensity, and, as it decreases, a portion will begin to be transmitted or refracted through the glass, which will increase in the same ratio as the reflected light decreases; and when the bundle of glass has turned 90°, in which position we see it represented at the bird's-eye view, and at the horizontal view in the next cut, the light D is wholly transmitted or refracted, as at CC, no portion being reflected. In such a position, the vibrations will be in a plane perpendicular to the reflecting surface; and such vibrations are always transmitted, and not reflected, as we also see has taken place in the polarization of the original beam of common light before referred to. Now let the second bundle of glass H H continue to turn, it will be seen that, as soon as it begins to move, the transmitted light CC will begin to decrease, a portion beginning again to be reflected, which, as the glass turns, will increase in intensity, in the same ratio as the transmitted light decreases, until it has turned another 90°, or reached 180° from the first position, as seen at the next cut, where the plane of reflection is again parallel to the plane in which the vibrations take place; consequently, the whole light is again reflected at EE, none being transmitted, for the same reason as before stated. On continuing the revolution, the same thing occurs at each quadrant of a circle. In the above figure, the bundle of glass H H is represented as having turned 270°, or ¾ of a circle. In which position the same thing occurs as at 90°, where the light D is wholly refracted or transmitted through the glass, as at CC; so that it is evident, in these experiments, that there are two positions in which the same ray of polarized light D is wholly reflected, and two other positions in which it is wholly transmitted by the analyzing bundle of glass; all of which are easily understood, by bearing in mind the description of the original ray of ordinary light, according to the undulatory theory, and the action of the first, or polarizing bundle of glass.





But, as it has been stated that a beam of ordinary light consists of a rapid succession of systems of waves comprising an immense number of rays, the vibrations of which are performed in every possible plane, it may be asked, what becomes of those rays, the vibrations of which are in planes inclined at different angles between the perpendicular and horizontal? Now it is of great importance to understand this clearly, as it will also enable us to understand how all the various and beautiful phenomena of colors are produced. The experiments, however, which we have been noticing with the analysing bundle of glass, will assist us in this; for if we refer again to fig. 3, we find that the vibrations of the polarized light D are represented as being performed in a perpendicular plane, that the second bundle of glass H H is so placed that such vibrations are parallel to its plane of reflection, and that, consequently, in such a position the light is again reflected, for the reasons there stated. Now, if we mark well what follows, when the second bundle of glass is made to turn round, we shall understand what becomes of those vibrations which are inclined at different angles, between the perpendicular and horizontal: for when the second bundle of glass begins to turn, its plane of reflection will begin to form different angles with the perpendicular and horizontal, and as soon as it begins to move, a portion of the reflected light begins to be transmitted, which, as it turns, increases in intensity; and when it has reached 45°, the light D is divided into two equal portions, one of which is reflected, and the other refracted or transmitted through the second bundle of glass, in each of which the vibrations are inclined 45° to the perpendicular, but at right angles to each other. Thus, in the reflected portion, the vibrations will be parallel to the plane of reflection, which is now inclined 45° to the perpendicular; but, in the transmitted portion, the vibrations will be in a plane perpendicular to the plane of reflection, and, of course, inclined 45° on the opposite side of the perpendicular, and, consequently, at right angles to the reflection portion.—It will be understood, then, from these experiments that, in a beam of ordinary light, those rays, the vibrations of which are inclined at different angles between the perpendicular and horizontal, are divided into two portions, one of which is reflected, and the other refracted or transmitted, the vibrations in each of which are at right angles to each other; but in neither are they in the same plane as in the original ray, the reflected portion being parallel to the plane of reflection, and the refracted portion being at right angles or perpendicular to the reflected portion; and, consequently, whatever angle the plane of reflection makes with the plane of vibrations of the original ray, the vibrations of the reflected portion will make the same angle, being always parallel. But the intensity of the reflected portion will decrease as the angle increases, being at its maximum or greatest intensity when parallel, and at its minimum or nothing when perpendicular; and *vice versâ* with the transmitted portion, which increases as the angle increases up to 90°, being at its maximum of intensity when perpendicular, and at its minimum or nothing when parallel.

(To be continued.)

ON PREDICTING THE WEATHER.

From a very great number of meteorological observations, made in England between the years 1677 and 1789, Mr. Kirman has deduced the following conjectures of the weather:—

1. That when there has been no storm before or after the vernal equinox, the ensuing summer is generally *dry*, at least five times in six. 2. That when a storm happens from an easterly point, either

on the 19th, 20th, or 21st of March, the succeeding summer is generally *dry* four times in five. 3. That when a storm arises on the 25th, 26th, or 27th of March, and not before, in any point, the succeeding summer is generally *dry*, four times in five.—4. If there be a storm at S.W., or W.S.W., on the 19th, 20th, 21st, or 22nd of March, the succeeding summer is generally *wet* four times in five.

To the above we shall add the following observations from the Encyclopedia Britannica:

1. A moist autumn with a mild winter, is generally followed by a cold and dry spring, which greatly retards vegetation. 2. If the summer be remarkably rainy, it is probable that the ensuing winter will be severe; for the unusual evaporation will have carried off the heat of the earth. Wet summers are generally attended with an unusual quantity of seed on the white thorn and dog-rose bushes. Hence the unusual fruitfulness of these shrubs is a sign of a severe winter. 3. The appearance of cranes, and birds of passage, early in autumn, announces a very severe winter; for it is a sign that it has already begun in the northern countries. 4. When it rains plentifully in May, it will rain but little in September, and *vice versâ*. 5. When the wind is S.W. during summer or autumn, and the temperature of the air unusually cold for the season, both to the feeling and the thermometer, with a low barometer, much rain is to be expected. 6. Violent temperatures, as storms or great rains, produce a sort of crisis in the atmosphere, which produces a constant temperature, good or bad for some months.

POUNCING DESIGNS UPON CLOTH.

THE ordinary means employed in this art are as follows:—Having pricked any design upon paper with a needle, it is dusted over with a piece of muslin, containing charcoal very finely pounded and sifted, the dust gets through the holes pricked on the design, and settles on the cloth which is to be embroidered; then with a black or white pencil, according to the color of the cloth, the marks left by the charcoal-dust are exactly to be followed.

The person who does this ought either to possess a knowledge of drawing, or else to have much adroitness, in order that the form of the design may be exactly preserved; but often before the pattern can be finished, the dust flies off, and thus occasions much embarrassment to the workers. Messrs. Revol and Rigoudet perceiving all the difficulties which attend this method of proceeding, have sought for, and at length ingeniously contrived a remedy; and the patent which they obtained for their invention having expired, we shall proceed to describe the means they employ.

Previously to this progress no means of fixing the dust upon the cloth had ever been ascertained, and every person who was employed in this work was obliged to trace with a pen or pencil the design formed by the dust, which not only occupied a great part of their time, but often occasioned mistakes in the figure to be embroidered. The new method possesses the advantages of being able to convey to the cloth the exact figure of the design, and facilitates the progress of the embroiderers, allowing them to attain the greatest exactitude in their work, and sparing them the trouble and time they had employed in retracing the design.

The method of preparing the composition of the powder for pouncing in black, is as follows:—

Place an *earthen* pot over the fire, and put into it a given quantity of gum mastic, adding thereto one-thirtieth part of wax, oil, tar, or pitch; when this is melted, throw into the pot as much lamp-black as may be deemed necessary for the color of the pounce, stirring the mixture all the time with an iron spoon. When all is well mixed, take it from the fire and pour it into sheets of paper, with the corners turned up to prevent its running over, and when well cooled, pound and sift it, and inclose it in a piece of muslin. Pounce with this whatever design it is intended to form upon any kind of cloth, and then it is instantly to be fixed on the cloth, by passing it over a pan of coals of a gentle heat, or by going over it with a hot iron. In this latter case, it is necessary to put a sheet of paper between the design and the iron; then the design will remain on the cloth neatly and correctly.

To make a White Powder.—Take a known quantity of gum mastic, and melt it in a glazed earthen pot over a slow fire; add to this 1-30th part of virgin wax, and when the whole is melted, add as much fine white silver as the gum and wax will imbibe, taking great care, all the while, to stir it in proportion as the white is added. The whole, when well mixed, must undergo the same operation as black powder.

ELECTRICAL EELS.

THE rivers and lakes of the lowlands of Venezuelas and Caracca are full of electrical eels, called by the Spaniards tremblador, (the trembler), and by the French colonists of Guyanne, the trembling eels. These eels have the astonishing faculty of striking their prey by a discharge of electrical matter. They are found also in the small ponds or pools interspersed in the vast plains lying between the Oronooco and the Apura.

The electrical eel is commonly about six feet long. The structure of its nervous system has been described with sufficient accuracy; but what has been said of its cellulary reservoirs, and the composition of its electrical batteries, is purely imaginary. The sensation occasioned by the shock is extremely painful; and in the parts affected it leaves a numbness: it resembles a sudden blow on the head, more than the commotion produced by the ordinary electrical fluid. The Indians have so great a terror of this animal, and such a repugnancy to come near it when living, that Mr. Humboldt had the greatest difficulty in procuring some of them for making experiments. For this purpose he staid several days near the Apura, in the small village of Calabozo, having learned that there was a great number of electrical eels near this river. His landlord made every effort to procure a number for him in vain. At length Mr. Humboldt resolved to go himself to the places which those eels inhabit. Mr. Humboldt and his companions witnessed amidst the abodes of the eels a sight altogether new and extraordinary. About thirty mules and horses had been hastily brought together from the neighbouring savannahs, where they live in a wild state in so great numbers, that the proprietor, when he is known, parts with them for about seven shillings each. The Indians surrounding the mules and horses, drove them into the water, and prevented them from returning to land by means of harpoons, affixed to the end of long bamboos, which they pushed forward toward the animals with loud vociferation. The electrical eels, or *gymnoti*, roused by the noise and tumult, come up to the surface of the waters; and swimming like so many livid serpents, glide under the bellies of the mules and horse, to whom they communicate commotions the most sudden and violent. The quadrupeds, in great agony, their hair standing on end, and their eyes rolling wildly with pain, make efforts for their escape in vain. In less than five minutes two of the horses were drawn under the water and drowned. Victory seemed to be declared on the side of the electrical eels; but their activity began to relax and languish: fatigued by the repeated efforts of their nervous energy, they launched the electrical fluid less frequently, and with less effect. The horses that had escaped destruction gradually recovered their strength; and in about a quarter of an hour the eels retired from the combat, in such a state of languor and exhaustion, that they were easily drawn to land, by means of small harpoons attached to cords.—*Humboldt's Travels.*

STRENGTH OF VARIOUS SUBSTANCES.

Mr. Rennie found the following weights requisite to crush a cubical inch of the undermentioned substances:—

Elm	1284 lbs.
White Deal	1928
English Oak	3860
Portland Stone	620
Cragleith Stone....	8688

Cubes of a quarter of an inch, of different metals, were crushed by the following weights:—

Cast Iron	9775 lbs.
Cast Copper......	7320
Fine Yellow Brass	10306
Wrought Copper..	6509
Cast Tin	966
Cast Lead	483

Some curious calculations were made by Mr. Dodd, the civil engineer, on the comparative tenacity of certain metals, in the pure and alloyed state. He says, "If I take copper, whose tenacity or strength on the square inch is 12 tons, 15 cwt. 1 qr. and 12 lbs., and to six parts of it add one of tin, whose tenacity is 1 ton, 19 cwt. 2 qrs. and 16 lbs. finite reason would tell me I should weaken the copper 1 ton, 10 cwt. 3 qrs. and 7 3-7 lbs., instead of which, I add 11 tons, 15 cwt. 3 qrs. and 6 lbs. to its tenacity or strength, as experiment demonstrates; again, if I take three parts of tin, and add to it one of lead, the weakest of all metals, its tenacity or strength, on the square inch, being only able to carry 7 cwt. 2 qrs. and 23 lbs., mere human reason, by mathematical calculation, would tell me the two together would carry only 1 ton, 11 cwt. 2 qrs. and 17 lbs, instead of which they will carry 4 tons, 11 cwt. and 8 lbs., which actual experiments demonstrate. How humiliating this to the knowledge of man, with all his chemical researches! How little does he know or comprehend of the secret workings of nature!"

The cohesive force of metals is very much increased by hammering or rolling them. To draw asunder a cylindrical bar of iron, of 1½ inch diameter, requires a force of 43 tons; while a bar of only 1 inch diameter, and whose cubic admeasurement is not half as much as the 1½-inch, requires a force of 29 tons to draw it asunder; and if we take a wire of 1-10 of an inch diameter, which has been rolled and drawn so repeatedly, in reducing it to that size, we shall find that it will require a force of 650 lbs. to draw it asunder.

ON THE IMPORTANT USES OF SODA.

Few articles are of greater importance to the arts, manufactures, and domestic economy, than soda. It is essentially necessary for making hard soap, and forms an excellent substitute for that article;—as four ounces of the former, and six of the latter, are fully equal to sixteen ounces, or one pound of soap, in washing, while it softens the hardest water, making a saving of from one-third to one-half the expense, according as the operation may be performed by hand, or by a machine. In the cleansing of worsted or flannel, the effects are fully evinced, which, when managed with warm water, soap, and potash, acquire an unpleasant odour, and are apt to shrink, in consequence of the rubbing, particularly if they be immersed in cold water; whereas, by using the fossil alkali, these inconveniences are said to be completely avoided, and neither the quality of the goods will be impaired, nor the hands of the women be injured in the same manner as generally happens with the common ley.

As frequent bathing or washing of the body greatly conduces to health, it has been recommended to dissolve, in the water so employed, a small portion of soda, or to wash with a towel wetted with a solution of soap and soda, which opens the pores, and removes the unpleasant odour arising from profuse perspiration; a similar application will be productive of equal advantages to horses that are employed for racing, post chaises, or other purposes where great exertions are required.

If a weak solution of soda be poured into foul bottle or casks, in which wine has been kept a considerable time, it will completely dissolve the crust of tartar which adheres to the inner surface. Boot tops, saddles, or bridles, are effectually cleansed by a solution of soda, preserving, at the same time, the original color of the leather. This alkali may likewise be employed for sweetening kitchen utensils, and particularly for removing grease or acids from copper vessels; because these concretions, when suffered to remain, form a strong poison. In a similar manner it is used for tin and iron vessels, to keep them from becoming rusty. Utensils of the dairy that acquire an unpleasant acid smell, during the summer, and particularly after a thunderstorm, though every attention be bestowed upon them, such fetor may be completely removed by a small portion of soda, which will render the milk vessels perfectly sweet; while it neutralizes and dispels the acid ferment imbibed by the wood, which would taint the milk. The crystals of soda are not less useful in a medicinal point of view; a solution of it forms an excellent gargle for cleansing the throat, mouth, and gums, both in a sound and in a deceased or ulcerated state; while it whitens the teeth, and dissolves all incrustations that may be formed on their surface without injuring the enamel. And, if a small quantity of this liquid be occasionally swallowed, after washing the fauces of the throat, it is said effectually to remove a fetid breath. Soda is, in many instances, preferable to magnesia, for correcting acidity in the stomach; nay, it is even asserted, that it prevents the gout, gravel, stone, and similar disorders; lastly, if the alkali be mixed with cream of tartar, in the proportion of fourteen parts of the former to twelve of the latter, it furnishes one of the mildest laxatives, namely, the Rochelle salt.

NOTES ON THE MONTH OF JUNE.

Weather	*Average of the Thermometer*	*Average of the Barometer.*	*Quantity of Rain*
LONDON	63 22	29 93	0 332 inch.
EDINBURGH....	57 2	29 66	1 935
	58 76	30 06	0 860

THE vigour and freshness of May is now more fully confirmed, and without yet yielding to the languidness of the sultry months of July and August; the young of animals sport in the glade, and luxuriate in the grassy and flower-enamelled fields. Vegetation no longer appears nipped with cold, and the gardener no longer finds it necessary to shield his plants from the slight frosts which he had reason to apprehend in the last month. May has been called the Venus of the seasons—June the Apollo—

> 'The only beauty of the year,
> Like the fam'd God of Belvider

ANIMATED NATURE.

If there are lingering songsters who have not before visited us, the first week of the month will bring them; and those which pursue their prey in the long evening can scarcely be said, before this time, to have completely thrown off their torpidity, and to revel in the blandness of the bright season. The Sedge Sparrow and the Fly-catcher we may not before have seen. The various Owls and Bats are now more active and frequent. The smaller birds have hatched their young, and are teaching them to provide for themselves; the larger fowl are not generally so early, nor are the birds of summer passage. It is not till near the close of the month, that the Partridge, the Rail, the Pheasant, the Lark, and the Grouse, have completed their nests and hatched their eggs—having waited for the grass to grow and the earth to become somewhat dry, before they ventured to lay their eggs. Nor are the Swallow tribe more early, although their habitation is so different. Towards the end of the month, the singing birds gradually retire to the woods, and, except the Nightingale and a few others, leave off their charming melody.

The insect world is all alive: Bees swarm—Wasps and Hornets abound—and numerous species of Butterfly, Moths, Beetles, and Flies, make their appearance.

VEGETABLE LIFE.

The flowers of the wild and waste are infinitely more abundant now than in any other month; by the botanist the last week of this month and the first of the next are more to be regarded than, perhaps, any others throughout the year. To enumerate what plants he may ordinarily find would occupy much space. It may suffice, perhaps, to draw his attention particularly in the early part of the month to the Sedge tribe, and to the Orchideous plants, and rather later to the family of the Grasses, the Umbelliferous plants, and the Roses, and to collect the leaves of those Willows of which he may previously have obtained the flowers. He will be aware that it is not till late in June that he will find many of our alpine or northern plants; the mountain regions are too cold to offer him most of their little beauties earlier than this. The plants of the valley are, however, rich and varied—he will find the Goat's-beard—the Pimpernel—Clover, in its various kinds, —Wild Thyme—the Pheasant's-eye—the Scabious —the Poppy—Larkspur—Corncockle—Greenweed —Bugloss—Borage—Mullein—Mallow—Hound's-tongue, not forgetting

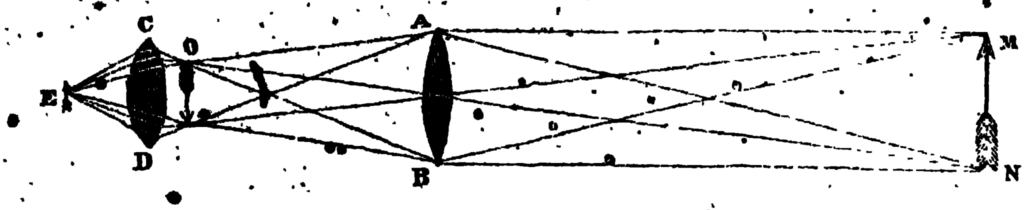
> "The Honeysuckle gay,
> Waked by the earliest breath of May,"

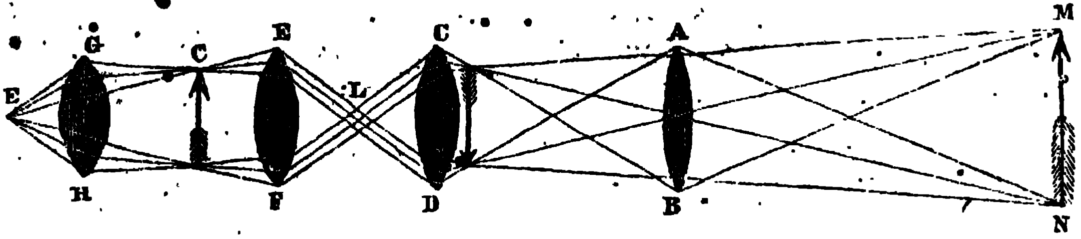
and hundreds of other plants equally beautiful, and many of them more plentiful than those we have enumerated. The Yellow Violet, and the pretty green Ladies' Mantle clothe the hills of Derbyshire. The Fern or Brake fills the thickets and sandy commons. The meadows are yellow with the Buttercup. The woods of Kent abound with the Orchis-tribe, and the hedges everywhere with the Hawthorn, the Rose and the Privet.

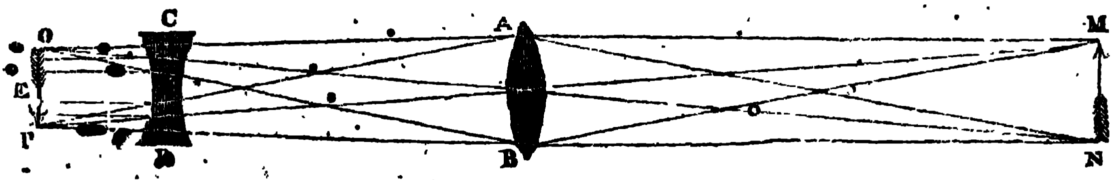
The Water plants, the tribe of Labiatæ, including the Mint, Thyme, &c. for the most part belong to a later season. Yet some of them towards the end of the month may be found in perfection, particularly the Yellow Iris, which so much abounds in many of our ditches, and on the river banks.

GARDENING OPERATIONS.

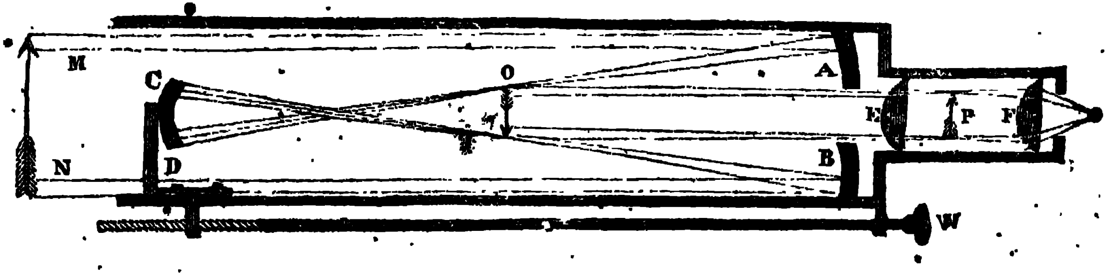
The season for sowing, for summer use, is now over, except, perhaps, a few late annuals. But in the early part of the month the gardener is glad to avail himself of any showery weather to transplant various of his crops—particularly flowering annuals and biennials. His main attention, however, is directed to preserve which he has before raised, by watering the smaller kinds, unmoving suckers from his fruit-bearing shrubs; training and trimming the summer shoots of his espalier trees, and removing and destroying insects. In the kitchen department, he will still sow Beans, Peas, and Turnips, for a late crop, also Carrots to be drawn young. He will also sow Endive, Brocoli, Savoy, Cucumbers for pickling, and other crops. Late in the month is the proper season to propogate numerous herbs, shrubs, trees, &c., by cuttings. Thus, Pinks and Carnations must be piped; the roots of Daisies, Thrift, Gentianella, &c. must be divided and planted out, and slips taken from the Lavender, the Rosemary, the Southernwood, and numerous of the pot-herbs. Those half hardy annuals which have been raised by artificial heat, may be removed into the borders, as soon as the Mulberry comes into leaf, which is considered by the gardener as a sign of the casual frosts and cold winds having left us for the season; this, therefore, affords a criterion not merely for him to remove his tender annuals to the open grounds, but warrants him to bring his greenhouse plants into the open garden, that their beauties may add to those of the general parterre. The gardener will not forget, also to take his bulbous roots from the ground, and to keep them dry till the autumn, well knowing that he thereby materially increases the vigour of their growth in the following season. He will be careful also to take off from them all offsets, that the sap of the parent may not be too much absorbed by the offspring being attached to her. Ranunculus and Anemony roots should be taken up as soon as their leaves decay. All these bulbs and tubers may be kept well on dry shelves, or buried in dry sand or sawdust—the roots, if large, not touching each other. The blossoming of the fruit trees is now over, and the gardener is already looking forward to his earlier crops of Strawberries, Raspberries, Cherries, Peas, and Potatoes, which should be in the market from the open ground during the third week of June.

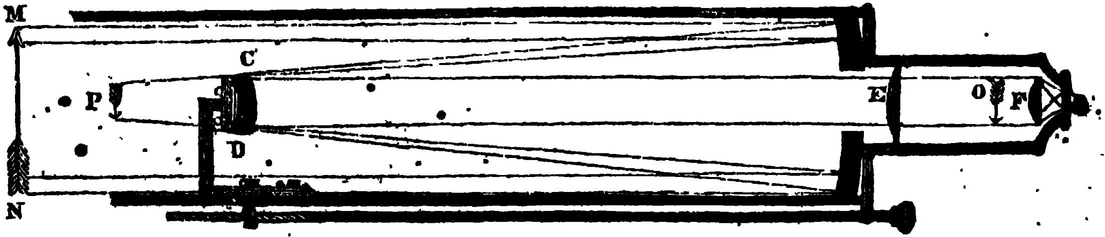


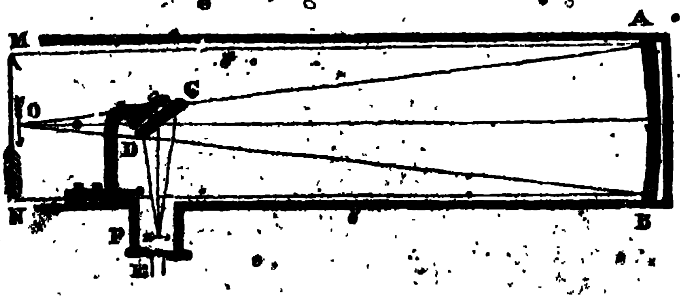


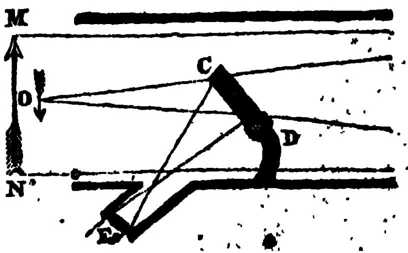


REFRACTING AND REFLECTING TELESCOPES.









REFRACTING AND REFLECTING TELESCOPES.

Astronomical Telescope.—That this telescope was invented in the thirteenth century, and perfectly known to Roger Bacon, and that it was used in England by Leonard and Thomas Digges before the time of Jansen or Galileo, can scarcely admit of a doubt. It is represented in fig. 1. It consists of two convex lenses A B, C D, the former of which is called the *object glass*, from its being next the eye E. The object glass is a lens with a long focal distance; and the eye glass is one of a short focal distance. An inverted image O of any distant object M N is formed in the focus of the object glass A B; and this image is magnified by the eye glass C D, in whose anterior focus it is placed. By tracing the rays through the two lenses, it will be seen that they enter the eye at E parallel. If the object M N is near the observer, the image O will be found at a greater distance from A B; and the eye glass C D must be drawn out from A B to obtain distinct vision of the image O. Hence it is usual to fix the object glass A B at the end of a tube longer than its focal distance, and to place the eye glass C D in a small tube, called the eye tube, which will slide out of, and into the larger tube, for the purpose of adjusting it to objects at different distances. The magnifying power of this telescope is equal to the focal length of the object glass divided by the focal length of the eye glass.

Telescopes of this construction were made by Campani Divini, and Huygens, of the enormous length of 120 and 136 feet; and it was with instruments 12 and 21 feet long that Huygens discovered the ring and the fourth satellite of Saturn. In order to use object glasses of such great focal lengths without the incumbrance of tubes, Huygens placed the object glass in a short tube at the top of a very long pole, so that the tube could be turned in every possible direction upon a ball and socket by means of a string, and brought into the same line with another short tube containing the eye glass, which he held in his hand.

As these telescopes were liable to all the imperfections arising from the aberration of refrangibility and that of spherical figure, they could not show objects distinctly when the aperture of the object glass was great; and, on this account, their magnifying power was limited. Huygens found that the following were the proper proportions:—

Focal length of the object glass.	Aperture of the object glass.	Focal length of the eye glass.	Magnifying power.
1 ft.	0·545 in.	0·605	20
3	0·94	1·04	33½
5	1·21	1·33	44
10	1·71	1·88	62
50	3·84	4·20	110
100	5·40	5·95	197
120	5·90	6·52	216

In the astronomical telescope, the object, O, is always seen inverted.

Terrestrial Telescope.—To accommodate this telescope to land objects which require to be seen erect, the instrument is constructed as in fig. 2, which is the same as the preceding one, with the addition of two lenses E F, G H, which have the same focal length as C D, and are placed at distances equal to double their common focal length. If the focal lengths are not equal, the distance of any two of them must be equal to the sum of their focal lengths. In this telescope the progress of the rays is exactly the same as in the astronomical one, as far as L, where the two pencils of parallel rays C L, D L cross in their anterior focus L of the second eye glass E F. These rays, falling on E F, form, in its principal focus, an erect image O, which is seen erect by the third eye glass G H, as the rays, diverging from O in the focus of G H, enter the eye in parallel pencils at E. The magnifying power of this telescope is the same as that of the former when the eye glasses are equal.

Galilean Telescope.—This telescope, which is the one used by Galileo, differs in nothing from the astronomical telescope, excepting in a concave eye glass C D, fig. 3, being substituted for the convex one. The concave lens C D is placed between the image O and the object glass, so that the image is in the principal focus of the lens. The pencil of rays A B O, A B P fall upon C D, converging to its principal focus, and will, therefore, be refracted into parallel lines, which will enter the eye at E, and give distinct vision of the object. The magnifying power of this telescope is found by the same rule as that for the astronomical telescope; it gives a smaller and less agreeable field of view than the astronomical telescope, but it has the advantage of showing the object erect, and of giving more distinct vision of it.

Gregorian Reflecting Telescope.—Father Zucchius seems to have been the first person who magnified objects by means of a lens and a concave speculum; but there is no evidence that he constructed a reflecting telescope with a small speculum.

James Gregory was the first who described the construction of this instrument, but he does not seem to have executed one; and the honor of doing this with his own hands was reserved for Sir Isaac Newton.

The Gregorian telescope is shown in fig. 4, where A B is a concave metallic speculum with a hole in its centre. For very remote objects the curve of the speculum should be a parabola. For nearer ones it should be an ellipse, in whose farther focus is the object, and in whose nearer focus is the image; and, in both these cases, the speculum would be free from spherical aberration. But, as these curves cannot be communicated with certainty to specula, opticians are satisfied with giving to them a correct spherical figure. In front of the large speculum is placed a small concave one, C D, which can be moved nearer to and farther from the large speculum by means of the screw V at the side of the tube. This speculum should have its curvature an ellipse, though it is generally made spherical. An eye-piece consisting of two convex lenses, E, F, placed at a distance equal to half the sum of their focal lengths, is screwed into the tube immediately behind the great speculum A B, and permanently fixed in that position. If rays M A, N B, issuing nearly parallel from the extremities of a distant object, fall upon the speculum A B, they will form an inverted image of it at O.

If this image O is farther from the small speculum C D than its principal focus, an inverted image of it, P, or an erect image of the real object, since O is itself an inverted one, will be formed somewhere between E and F, the rays passing the opening in the speculum. This image P might have been viewed and magnified by a convex eye glass at F, but it is preferable to receive the converging rays upon a lens E, called the field glass, which hastens their convergence, and forms the image of O in the focus of the lens F, by which they are magnified ; or, what is the same thing, the pencils diverging from the image P are refracted by F, so as to enter the eye parallel, and give distinct vision of the image. If the object M N is brought nearer the speculum A B, the image of it, O, will recede from A B and approach to C D; and, consequently, the other image P in the conjugate focus of C D will recede from its place, and cease to be seen distinctly. In order to restore it to its place, we have only to turn the screw W, so as to remove C D farther from A B, and, consequently, farther from O, which will cause the image P to appear perfectly distinct as before. The magnifying power of this telescope may be found by the following rule:—

Multiply the focal distance of the great speculum by the distance of the small mirror from the image next the eye, as formed in the anterior focus of the convex eye glass, and multiply also the focal distance of the small speculum by the focal distance of the eye glass. The quotient, arising from dividing the former product by the latter, will be the magnifying power.

This rule supposes the eye-piece to consist of a single lens.

The following table, showing the focal lengths, apertures, powers, and prices of some of Short's telescopes, will exhibit the great superiority of reflecting telescopes to refracting ones :—

Lengths in feet.	Aperture in inches.	Magnifying powers.		Price in guineas
1.	3·0	35 to	100	14
2	4·5	90	300	35
3	6·3	100	400	75
4	7·6	120	500	100
7	12·2	200	800	300
12	18·0	300	1200	800

Cassegrainian Telescope.—The Cassegrainian telescope, proposed by M. Cassegrain, a Frenchman, differs from the Gregorian only in having its small speculum C D, fig. 5, convex instead of concave. The speculum is, therefore, placed before the image P of the object M N, and an erect image of M N will be formed at O between E and F exactly as in the Gregorian instrument. The advantage of this form is, that the telescope is shorter than the Gregorian, by more than twice the focal length of the small speculum; and it is generally admitted that it gives more light, and a distincter image, in consequence of the convex speculum correcting the aberration of the concave one.

Newtonian Telescope.—The Newtonian telescope, which may be regarded as an improvement upon the Gregorian one, is represented in fig. 6, where A B is a concave speculum, and O the inverted image which it forms of the object from which the rays M N proceed. As it is impossible to introduce the eye into the tube to magnify this image without obstructing the light which comes from the object, a small plane speculum C D, inclined 45° to the axis of the large speculum, and of an oval form, its axes being to one another as 7 to 5, placed between the speculum and the image O, in order to reflect it to a side at P, so that we can magnify it with an eye glass E, which causes the rays to enter the eye parallel. The small mirror is fixed upon a slender arm, connected with a slide, by which the mirror may be made to approach to, or recede from the large speculum A B, according as the image O approaches to, or recedes from it. This adjustment might also be effected by moving the eye lens E to or from the small speculum. The magnifying power of this telescope is equal to the focal length of the great speculum divided by that of the eye glass.

As about half of the light is lost in metallic reflexions, Sir Isaac Newton proposed to substitute, in place of the metallic speculum, a rectangular prism, in which the light suffers total reflexion.—For this purpose, however, the glass is required to be perfectly colorless and free from veins, and hence such a prism has almost never been used. Sir Isaac also proposed to make the two faces of the prism convex, and by placing it between the image O and the object, he not only erected the image, but was enabled to vary the magnifying power of the telescope. The original telescope, constructed by Sir Isaac's own hands, is preserved in the library of the Royal Society.

The following table shows the dimensions of the Newtonian telescopes, which has been computed by taking a fine telescope made by Hawksbee, as a standard :—

Focal length of great speculum.	Aperture of speculum.	Focal length of eye glass.	Magnifying power.
1 ft.	2·23 in.	0·129 in.	93
2	3·79	0·152	158
3	5·11	0·168	214
4	6·36	0·181	265
6	8·64	0·200	300
12	14·50	0·238	604
24	24·41.	0·283	1017

On account of the great loss of light in metallic reflexions, which, according to the accurate experiments of Mr. R. Potter, amounts to 45 rays in every 100, at an incidence of 45°, and the imperfections of reflexion, which, even with perfect surfaces, makes the rays stray *five* or *six* times more than the same imperfections in refracting surfaces. Dr. Brewster proposed to construct the Newtonian telescope, as shown in fig. 7. O is the image of the object, C D an achromatic or double prism, which refracts the image O into an oblique position, so that it can be viewed by the eye at E through a magnifying lens. Nothing more is required by the prism than to turn the rays as much aside as will enable the observer to see the image without obstructing the rays from the object M N. As the prisms of crown and flint glass which compose the achromatic prism may be cemented by a substance of intermediate refractive power, no more light will be lost than what is reflected at the two surfaces.

In place of setting the small speculum, C D, of the Newtonian telescope, Fig. 6, at 45°, to the incident rays, Dr. Brewster proposed to place it much more obliquely, so as to reflect the image out of the way of the observer, and no farther. This would of course require a plane speculum, C D, of much greater length; but the greater obliquity of the reflection would more than compensate for this inconvenience. It might be advisable, indeed, to use a small speculum of dark glass, of a high refractive power, which at great incidences reflects as much light as metals, and which is capable of being wrought to a much finer surface. The fine surfaces of some crystals, such as ruby silver, oxyde of tin, or diamond, might be used.

A Newtonian reflector, *without an eye glass*, may be made by using a reflecting glass prism, with one or both of its surfaces concave, when the prism is placed between the image O and the great speculum, so as to reflect the rays parallel to the eye. The magnifying power will be equal to the focal length of the great speculum, divided by the radius of the concave surface of the prism, if both the surfaces are concave, and of equal concavity, or by twice the radius, if only one surface is concave.

SPOTS, MOUNTAINS, &c., IN THE MOON.

(*Resumed from page 68, and concluded.*)

It has long been a disputed point among astronomers, whether or not the moon is surrounded by an atmosphere. Those who deny that she is, say that the moon always appears with the same brightness when our atmosphere is clear, which could not be the case if she were surrounded by an atmosphere like ours, so variable in density, and so often obscured by clouds and vapours.

A second argument is, that when the moon approaches a star, before she passes between it and the earth, the star neither alters its color nor its situation, which would be the case if the moon had an atmosphere, on account of the refraction which would both alter the color of the star, and also make it appear to change its place.

A third argument is, that as there are no seas or lakes in the moon, there is, therefore, no atmosphere, as there is no water to be raised up into vapour. But those who contend that the moon is surrounded by an atmosphere, deny that she always appears of the same brightness, even when our atmosphere appears equally clear. Instances of the contrary are mentioned by Hevelius and some other astronomers, but it is unnecessary to take any further notice of them here. In the case of total eclipses of the moon, it is well known that she exhibits very different appearances, which it is supposed are owing to changes in the state of her atmosphere. It is remarked by Dr. Long, that Newton has shown that the weight of any body on the moon is but a third part of the weight of what the same body would be on the earth, from which he concludes that the atmosphere of the moon is only one-third part as dense as that of the earth, and therefore it is impossible to produce any sensible refraction on the light of a fixed star which may pass through it. Other astronomers assert that they have observed such a refraction; and that Jupiter, Saturn, and the fixed stars, had their circular figures changed into an elliptical one on these occasions. But although the moon be surrounded by an atmosphere of the same nature as that which surrounds the earth, and to extend as far from her surface, yet no such effect as a gradual diminution of the light of a fixed star could be occasioned by it, at least none that could be observed by a spectator on the earth. For at the height of 44 miles our atmosphere is so rare, that it is incapable of refracting the rays of light; now this height is only the 18th part of the earth's diameter, but as clouds are never observed higher than 4 miles, it therefore follows that the obscure part of our atmosphere is about the 2000th part of the earth's diameter, and if the moon's apparent diameter be divided by this number, it will give the angle under which the obscure part of her atmosphere will be seen from the earth, which is not quite one second, a space passed over by the moon in less than two seconds of time. It can, therefore, scarcely be expected that any obscuration of a star could be observed in so short a time, although it do take place.

As to the argument against a lunar at drawn from the conclusion that there ar or lakes in the moon, it proves nothing, is not positively known whether there is in the moon or not.

The question of a lunar atmosphere se at last settled by the numerous and accur vations of the celebrated astronomers, and Piazzi, who have proved as convincin nature of the subject seems to allow, that has really an atmosphere, though much l than ours, and scarcely exceeding in hei of the lunar mountains.

It is remarked by Dr. Brewster, "The scenery of the moon bears a stronger res to the lowering sublimity and terrific rugg the Alpine regions, than to the tamer ineq less elevated countries. Hugh masses of at once from the plains, and raise thei summits to an immense height in the projecting crags spring from their rugge and, threatening the valleys below, seem t fiance to the laws of gravitation. Around of these frightful eminences are strewed r loose and unconnected fragments, which ti to have detached from their parent masses, a we examine the rents and ravines which ac the overhanging cliffs, we expect every that they are to be torn from their base, the process of destructive separation which only contemplated in its effects is about t hibited before us in tremendous realit mountains called the Appennines, which t portion of the moon's disc from north-east t west, rise with a precipitous and craggy fr the level of the *Mare* Imbrum. In som their perpendicular elevation is above fou and though they often descend to a much lo they present an inaccessible barrier to th east, while on the south-west they sink i declivity to the plains."

The caverns which are observed on the surface are no less remarkable than the r mountains, some of them being three or fo deep, and forty in diameter. A high angu of rocks, marked with lofty peaks and little generally encircles them, an insulated m frequently rises in their centre, and sometin contain smaller cavities of the same natu themselves. These hollows are most num the south-west part of the moon, and it this cause that this part of the moon is m liant than any other part of her disc. The tainous ridges which encircle the cavities, the greatest quantity of light, and, from the in every possible direction, they appear n time of full moon, like a number of brilli diations issuing from the smallest spot, Tycho.

It is difficult to explain, with any degree bability, the formation of these immense c it is highly probable that the earth would the same figure, if all the seas and lakes w moved; and that the lunar cavities are eit tended for the reception of water, or that t the beds of lakes and seas which have forme isted in the moon.

The circumstance of there being no water moon affords a strong proof of the truth theory.

GRANITE,

Is an aggregate rock, the essential ingredients of which are feldspar, quartz; and mica, being the same as those of gneiss, from which granite differs chiefly in the arrangement of the three component parts: their being mingled without order or regularity, produces a granular structure, while that of gneiss is generally slaty. The use of granite for architectural and economical purposes, is perhaps no where more amply displayed than at Petersburgh, where not only the imperial and other palaces, but even ordinary dwelling-houses, have their lower parts lined with slabs of granite. The left bank of the great Neva, from the Foundry to the Gulf of Cronstadt, and both banks of the Fontanka and of the Catharine canal, are lined by high walls constructed of such slabs of granite; as are many bridges over the Neva, balustrades, &c. The pillars, stairs, balconies, &c. in the palace of Cronstadt, are almost all of the finest kinds of granite. Those employed for ornamental architecture are cut and polished by lapidaries; but those intended for less delicate purposes, such as common slabs, steps, cylinders, troughs, &c. are worked by peasants, particularly by those of Olonesk. The government towns, however, Moscow not excepted, are too distant from the chief granite mountains, to be enabled to make frequent use of that rock for the above purposes. Granite has been more particularly applied, together with sienite, for the purposes of architecture and statuary, by the ancients, especially by the Egyptians; and many very interesting monuments of their skill and patience are still existing in the collections of antiquities. Mr. Brande has divided the different granites used in the arts after their predominant colors; the following are the principal varieties, in which, however, the black-and-white kind is not included, one of its ingredients being hornblende, which assigns it a place among the sienites.

Grey Granite of Chessi, in the department of the Rhine, consists of white quartz and black mica, with large crystals of rose-colored feldspar. The columns of the Eglise d'Enée (ancient temple of Augustus) at Lyons, are of this kind of granite, which has also been worked by the Romans.

Grey Granite of Thain, consists of grey quartz, black mica, and white feldspar crystals, which are sometimes from two to three inches long. The quarries of this granite are on the road from Lyons to Valence, on the right bank of the Rhone. It is very well adapted for the construction of large monuments. The granite of St. Peray, not far from Thain, is exactly like this, except that its feldspar crystals are of a rose color.

Grey Granite of Levezzi, a small island near Bonifacio, south of Corsica, in the straits which separate that island from Sardinia, is composed chiefly of small irregular crystals of feldspar, mixed with a little black mica, besides which it contains also feldspar crystals, of a milk-white color. In the quarry of that island a large unfinished column is to be seen, which had been relinquished by the Roman workmen.

Grey Granite of Elba.—Its grain is pretty uniform; its color sometimes approaches to light violet. There are four columns of this variety to be seen in the Musée Napoleon: they were taken out of the church which contained the tomb of Charlemagne, at Aix-la-Chapelle. The grey granites are much more common than the green or greenish, of which the following deserve to be mentioned.

Antique Green Granite.—Its predominant ingredient is white quartz, with here and there some light green feldspar. There is a column of it in the Villa Pamfili, near Rome.

Fine Grained Antique Granite.—(Basalte verd oriental.) The component parts of this sort are so minute and intimately blended, that they can scarcely be distinguished by the naked eye. Its color approaches to deep olive. It is very hard and takes a fine polish. The Egyptians have much employed it for the construction of monuments; and several statues of it may be seen in the Capitol and the Villa Albani. There is another variety with white spots, known at Rome under the name of *Basalto Orientale pidocchioso*; but it is very rare, for there are but two columns of it in existence, namely, in the church of St. Pudentiana at Rome. Some varieties bearing that name are selenite.

Granite of St. Christophe: composed of violet quartz, white feldspar, and green mica. This magnificent rock is found at Oisans, in the department of the Isere.

Corsican Orbicular Granite.—This beautiful rock (which probably belongs to the sienite formation) was discovered by M. Barral, in the island from which it derives its name. Its composition is very extraordinary; it has a basis of ordinary grey granite, which, however, in most parts exhibits a considerable portion of hornblende. But what more particularly characterizes it, is a number of balls, of from one to two inches in diameter, each composed of several concentric and perfectly parallel layers, the outermost of which, generally white, opaque, and two or three lines thick, is composed of quartz and feldspar, blended in various proportions, and exhibiting a radiated appearance, rather converging towards the centre of the ball. The second layer, which is of a greenish black color, and about one line thick, is composed of fine laminar hornblende; and this is succeeded by a white and usually translucid quartz layer, of about four or five lines in thickness, inclusive of two or three very thin layers of hornblende, that are commonly seen within the substance of this third principal layer. Each of these layers is generally of equal thickness in the whole of its circumference. These three parts may be considered as the coating: the interior of each ball is less defined than the surrounding layers, and consists of a blackish and a whitish substance, the former surrounded by, and passing into the latter, the centre of which is usually a dark grey spot. The quarry of this rock is unknown, a single block only having been found in the gulf of Valinco, in Corsica: its weight was about 80 lb.; but it was soon broke into small fragments, which are now distributed among collectors. There is a beautiful vase of it, one foot six inches high, in the cabinet of M. Dedrée. The granite of Corsica is figured by M. Faujas de St. Fond, in his *Essai de Géologie*, and in Mr. Sowerby's *Exotic Mineralogy*. Among the red granites, we have what is called *red oriental granite*, which usually contains hornblende, often in large separate patches.

Red Granite of Ingria.—"This granite," says M. Patrin, "is distinguished from others in this, that the feldspar, instead of being in grains, or parallelopiped crystals, as in most other granites, constantly appears in the shape of round or oval pieces, of from half an inch to two inches in diameter. This granite takes a very fine polish, and in this state exhibits the feldspar in the shape of white, round, or oval *(chatoyant)* spots, in [illegible] reddish ground. The rock, which serves as a pedestal of the equestrian statue of Peter the Great, at St. Petersburgh, is of this granite: the block was originally 32 feet long, 21 feet thick, and 17 feet wide; but, in order to give to its present shape, imitative of a picturesque natural rock, it has been much diminished in size. This block was disengaged from a swamp, about forty versts from Petersburgh: its weight was calculated to be above three millions of pounds." We have seen several fragments that were detached from the very block forming the pedestal of the statue; but in none of them did we observe the form ascribed by Patrin to the feldspar. The public summer promenade-garden at Petersburgh is decorated with a superb colonnade of this granite: the columns, which are sixty in number, are of the Tuscan order; their shafts, made of one piece, are about twenty feet high, and three feet in diameter. The island called Kotlin-Ostrow, on which is the fortress of Cronstadt, is covered with blocks of this granite, the feldspar of which is sometimes of the kind called Labradorstone.

Red Granite of the Vosges Mountains.—This granite is composed of large laminæ of rose-colored feldspar, grey grains of quartz, and small scales of mica. It has so strong a resemblance to the Egyptian red granite, that it is difficult to distinguish them. Its quarries are on the heights of Montaujeu, near the Papean mountains, in the Vosges.

Violet Granite of Elba.—The feldspar of this variety is in large violet crystals. The pedestal of the equestrian statue, in the Piazza della Santissima Annonziata at Florende, is made of it, as also the *sotles* in the chapel of St. Laurence in the same town.

Rose-colored Granite of Bareno.—This beautiful granite consists of flesh-colored feldspar, white quartz, and some grains of black mica. Considerable quarries of it are found on the borders of the Lago Maggiore, which are worked without intermission, for supplying Milan, and the whole of the neighbouring country, with this granite. It takes a very fine polish: here and there it exhibits ribands or zones, of a grey color, which are composed of the same ingredients as the rest of the mass, but reduced into very minute particles. Many columns, porticos, &c. are seen of it at Milan. The name of *graphic granite* is given to those kinds in which the feldspar forms large concretions, intermixed with grey quartz crystals, exhibiting, when cut transversely, angular, mostly shaped like a 7; while others are less regular, and bear a distant resemblance to rude alphabetical writing. They are not considered to be genuine granite by some mineralogists.

Graphic Granite of Portsoy.—The feldspar is of various tints of pale flesh-red; the quartz dark, but transparent, with now and then some small particles of mica. This rock is minutely described by Dr. Hutton.

Graphic Granite of Siberia.—Its feldspar is of a yellowish white, or reddish color; the quartz, exhibiting figures similar to those of the quartz in the preceding sort, is of the variety called *smoky topaz.* Mica occurs in it in small nests, and in acicular crystals.

Graphic Granite of Autun.—Of a pale rose color; quartz crystals grey, very numerous; found in the neighbourhood of Autun, department of Saône and Loire, particularly at Marmagne. This, in Mr. Brand's opinion, is the most beautiful of all granites. Another variety of this stone is found at the same place: its feldspar is white; the quartz grey, in small crystals; it is susceptible of a very fine polish.

Graphic Granite of Corsica.—Likewise of a rose color; but generally paler than that of Autun, from which it is also distinguishable by its quartz crystals being larger, and at greater distance from each other. It contains some thinly disseminated bronze-colored mica, and takes a fine polish.

The above gives no account whatever of those granites which our own islands produce, and this is the more remarkable, as we can boast of some of the finest granite in the world, both of the red and the grey species. The fine red granite procured from the quarries of Devonshire is not to be surpassed in color, clearness, and capability of taking a high polish by any other in the world. There are two splendid columns of it, each made of a single block, in the King's Library, at the British Museum, which cost £1000 a piece. They were made in rivalry to similar columns at Petersburgh, of the red granite of Ingria, as before alluded to. Adjoining these columns are two equally magnificent pilasters of the grey granite of Aberdeen, also of a single block. The value of this species to us can scarcely be too highly appreciated; it is that species of which our bridges and great buildings are erected, and which broken into fragments of requisite size is used to pave the public thoroughfares. The Irish granite, some of which is grey, other flesh-colored, is also much esteemed.

SOLUBLE GLASS.

A SIMPLE silicate of potassa or soda, which unites perfect solubility in boiling water to some of the general properties of common glass. In the liquid state, it may be applied to cloth or wood, for the purpose of rendering them incombustible. In fact, by the evaporation of the water in which it is dissolved, a layer of a substance capable of fusing when heated, is deposited on these bodies, that protects them from the contact of air necessary for their combustion. The following account of its manufacture and uses is derived from a translation by Professor Renwick, of the *Traité de Chimie applique aux Arts, par M. Dumas.*

Preparation.—Soluble glass may be obtained by dissolving pure silica, obtained by precipitation, in a boiling solution of caustic potassa; but this process, being both inconvenient and costly, cannot be practised upon a large scale. When sand and carbonate of potassa are heated together, the carbonic acid is never wholly driven off, except when the sand is in excess; but the whole of the carbonic acid may be expelled by adding powdered charcoal to the mixture, in such proportion that the carbonic acid of that part of the carbonate which is not decomposed by the carbon, the carbonic oxide escapes, and the potassa thus freed, either sublimes, or combines with the glass already formed.

The sand freed from lime and alumina, and carbonate of potassa (pearlash) are taken in the proportion of 2 of the latter to 3 of the former, and to 10 parts of pearlash and 15 of sand, 4 parts of charcoal must not be taken; on the contrary, if the form of potash employed be not sufficiently pure, a larger proportion of charcoal may be advantageously employed. This substance accelerates the fusion of the glass, and separates from it all the carbonic acid, of which there would otherwise remain a small quantity that would have an injurious effect. In other respects, the same precautions that are employed in the manufacture of common glass are to be observed. The materials must be first well mixed, then fritted, and finally melted in a glass pot, until the mass becomes liquid and homogeneous. The melted matter is taken out of the pot with an iron ladle, and the pot is then filled with fresh *frit*. Thirty pounds of pearlash, 45 of sand, and 12lbs. of powdered charcoal may be taken for a charge; with this quantity the heat must be continued for five or six hours. The crude glass thus obtained is usually full of air bubbles; it is as hard as common glass of a blackish grey color, and at others is yellowish or reddish: these are indications that the quantity of charcoal has not been sufficient. If it be exposed for some weeks to the air, it undergoes slight changes, which rather tend to improve than injure its qualities.* It attracts a little moisture from the air, which slowly penetrates its mass, without changing its aggregation or its appearance; it merely cracks; and a slight efflorescence appears at its surface. If it be exposed to heat, after it have undergone this change, it swells up, owing to the escape of the aqueous matter it has absorbed. In order to prepare it for solution in boiling water, it must be reduced to powder by stampers; if this were not done, it would dissolve too slowly. One part of glass requires from 4 to 5 of water for its solution. The water is first heated to ebullition; this must be continued three or four hours, until no more glass is dissolved: the liquor will then have acquired the proper degree of concentration. If the ebullition be checked before this state is attained, carbonic acid will be absorbed by the potassa from the air, which will produce an injurious effect; for the same reason, too great a quantity of water must not be employed, for during the long evaporation it will readily combine with the potassa, and cause a precipitation of the silica. When the liquor becomes too thick, before the whole of the glass is dissolved, boiling water must be added. When the solution has acquired the consistence of syrup, and a density of 1.24 to 1.25, it is sufficiently concentrated, and fit for use. It is then permitted to rest, in order that the insoluble parts may be deposited; while it is cooling, a pellicle forms upon the surface, which after a time disappears of itself or may be re-dissolved by depressing it in the liquor. This pellicle begins to appear during the ebullition, and its concentration. When the crude glass is of a proper composition it contains but a few saline impurities, and no sulphuret of potassium, it may be treated in the way we have described; but if it contain any notable proportion of these substances, they must be separated before it is dissolved; this separation may be effected in the following manner:—The powdered glass is exposed to the action of the air for three or four weeks, during which time in moist weather, it must be broken up. The glass, as we have stated, attracts moisture from the air, and the foreign substances either separate or effloresce. It then becomes easy to remove them from the glass. It is sprinkled with water, and frequently stirred. At the end of three hours the liquor is removed, it will then contain a part of all the saline impurities, and a little of the silicate of potassa; the powder is again to be washed with fresh water, and the solution leaves nothing to be desired. To preserve it in the liquid form no particular care is necessary, as even after a long space of time it undergoes no perceptible change, if the solution have been properly prepared. The only precaution is not to allow too free an access of air to it. A similar product may be obtained by using a carbonate of soda instead of one of potassa. In this case, two parts of the soda of the shops is required for one of silica. This glass has the same properties as the other, but is more valuable in its uses. The solution of these two kinds of glass may be mixed in any proportion whatever, and this mixture is more serviceable in some cases, than either of them separately.

Properties.—Soluble glass forms a viscid solution, which when concentrated becomes turpid and opalescent: it has an alkaline taste and re-action. The solution mixes in all proportions with water. When the density of the solution is 1.25, it contains nearly 28 per cent. of glass; if the concentration be carried beyond this point, it becomes so viscid that it may be drawn out in threads like molten glass. Finally, the liquor passes to the state of a vitreous mass, whose fracture is conchoidal; it then resembles common glass, except in hardness. When the solution is applied to other bodies, it dries rapidly at common temperatures, and forms a coat like a varnish. Soluble glass when dried does not undergo any perceptible change when exposed to the air, nor does it attract from it either moisture or carbonic acid; neither has the carbonic acid of the atmosphere any well marked action on the concentrated solution; but when a current of carbonic acid is passed through the solution, the glass is decomposed, and hydrate of silica deposited. But a weak solution becomes turbid on exposure to the air, and is after a time decomposed wholly. When the glass is impure, an efflorescence is formed after a while, which may be produced either by the carbonate and hyposulphate of potassa, or by chloride of potassium. Soluble glass dissolves gradually without residuum in boiling water; but in cold water the solution is so slow as to have led to a belief that it does not dissolve at all. It however never becomes entirely insoluble, except when it contains a much larger proportion of silica, or when it is mixed with other bodies, such as the earths, metallic oxides, &c., with which double or triple salts are formed, as is the case in the common glasses. Soluble glass which has been exposed to the air, and is afterwards submitted to the action of heat, swells and cracks at first, and melts with difficulty; it then loses about 12 per cent. of its weight. It therefore contains, even when solid, a considerable quantity of water, which it does not lose when simply dried by exposure to the air. Alcohol precipitates it unaltered from its solution in water. When the solution is concentrated, but little alcohol is required for precipitation, and it need not be highly rectified. Pure soluble glass may therefore be easily obtained from an impure solution by the use of alcohol. The alcohol being added, the gelatinous precipitate is permitted to settle; the supernatant liquor is decanted, the precipitate collected, rapidly stirred after the addition of a little cold water, and subjected to pressure. In truth, however, this process is attended with some loss, for even cold water will rapidly dissolve the precipitated glass in consequence of its minute division. The acids decompose the solution of glass. They also act upon it when solid, separating the silica in the form of powder.

(To be continued)

Chinese Weights.—An interesting experiment has recently been made at the Royal Mint, in the presence of its principal officers. A set of Chinese weights was compared with the English standard, and the results were found perfectly to correspond with similar comparisons made in China, nearly a century ago, by the missionary Duhalde, of scientific memory.

MEDICAL RECEIPTS.

Poison for Bugs.—Dissolve 1 ounce of bichloride of mercury (corrosive sublimate) in a pint of rectified spirits of wine, and add 4 ounces each of castor oil and turpentine. 2d. receipt.—Reduce 1 ounce of bichloride of mercury, and 1 of white arsenic to a fine powder, mix with it 1 ounce of sal ammoniac in powder, 2 ounces each of oil of turpentine and yellow wax, and 8 ounces of olive oil; put all these in a pipkin placed in a pan of boiling water; and, when the wax is melted, stir the whole till cold in a mortar.—*Brande's Chemistry.* 3rd. —A solution of sulphate of copper.

Fly Water.—Either of the above receipts may be used, but being poisonous, should not be placed where children have access. What is as good, and perfectly harmless, except to the flies, is the water in which quassia has been boiled. It should be somewhat sweetened.

Balm of Gilead.—(Solomon's.) An empirical medicine, which is nothing but a disguised preparation of tincture of cardamoms.

Balm of Mecca.—This is rarely, if ever, to be produced genuine in Turkey, much less in England. It is a liquid resin, of a whitish color, approaching to yellow, with a strong aromatic smell resembling that of lemons, and a pungent high-flavored taste. It is much esteemed in the East as a cosmetic.—What is sold here for balm of Mecca, is some of the finer balsams scented with oil of lemons.

Balm of Rakasiri. (Jordan's.)—An empirical nostrum, prepared by disguising common gin with oil of rosemary.

Balsam of Honey. (Hill's.)—A nostrum prepared with equal weights of honey and balsam of Tolu, and diluted with rectified spirit. Without the spirit it would be a good expectorant.

Balsam of Honey. (Pectoral.)—This is simply the Alcoholic tincture of Benzoin, or Balsam of Tolu. It contains no honey.

Balsam of Horehound. (Ford's.)—A nostrum, the active ingredient of which is opium; being an infusion of horehound and liquorice-root with a large proportion of brandy and opium, with camphor, benzoin, squills, and honey; and flavored with oil of anise.

Balsam of Life.—This is merely the compound decoction of aloes.

Balsam of Liquorice.—A nostrum prepared with liquorice, opium, and balsum of Tolu.

Barclay's Antibilous Pills.—Take 2 drams of extract of colocynth, 1 dram of extract of jalap, 1½ dram of almond soap, 3 drams of guaiac, 8 grains of potassio-tartrate of antimony, 4 drops each of the essential oils of juniper, caraway, and rosemary, make into a mass with syrup of buckthorn, and divide into five dozen pills.

Bateman's Pectoral Drops.—A nostrum whose basis is tincture of castor. Take 2 ounces of castor, 1 ounce each of opium and oil of anise, 8 ounces of camphor, 2 ounces of sweet fennel-seeds, 4 ounces of tincture of antimony, and 10 pounds of proof spirit; color it with cochineal. Other formulæ are given, varying in the proportions, and sometimes in the ingredients.

Bates's Anodyne Balsam.—This nostrum is the compound tincture of soap and opium, and is prepared with 1 ounce of tincture of opium, and 2 ounces of opodeldoc.

Battley's Green Senna Powder.—A nostrum, supposed to be senna leaves heated till they become yellow, and then mixed with powdered charcoal.

Battley's Liquor Opii Sedativus.—A secret preparation, which is a powerful narcotic, of more uniform and mild effect than other preparations of opium. It is chiefly composed of acetate of morphia, and may be imitated by macerating with tartaric acid the dregs left after making tincture of opium. Mr. Battley's preparation does not keep well without the addition of spirits, which impair its superiority as a mild narcotic.

Bear's Grease.—There are two sorts of this: one of the consistence of thick olive oil, which is procured by boiling, from the fat about the caul and the intestines of the animal; the other, much harder, and in appearance like frozen honey, obtained from about the kidneys. Both sorts have a rank, rancid, and intolerable smell. Rancid lard is often sold for bear's grease.

Bittering, or corruptly *Bittern*, a fraudulent preparation, sold to brewers and others for adulterating beer, and composed of coculus indicus, liquorice, tobacco, quassia, and sulphate of iron or *copperas.* A similar preparation is sold for the same purpose under the name of bitter balls.

Black Drop, or the Lancaster or Manchester black drop, or the Quaker's black drop. The following is the original receipt, published by Dr. Armstrong: take ½ pound of opium sliced, and 3 pints of good verjuice, 1½ ounce of nutmegs, and ½ ounce of saffron. Boil to a proper thickness, then add ¼ pound and two spoonfulls of yeast; set the whole in a warm place near the fire, for six or eight weeks, then in the open air, till it becomes a syrup, when it is to decanted, filtered, and bottled up, with a little sugar added to each bottle. One drop equals three of the Tincture of Opium.

Black Reviver.—Boil in 2 pints of water down to 1, 2 ounces each of Aleppo galls, in powder, and of logwood, 1 ounce of gum arabic, then add 1 of sulphate of iron. This may be evaporated to a powder.

Black Wash.—Rub together 1 pound of lime water and 2 ounces of chloride of mercury.

Blaine's Powder, for the distemper in dogs, is a disguised preparation of the sulphuret of tin.

Bleaching Liquid.—What is sold under this name is a solution of the chloride of lime, which is also kept in the market under the name of *Bleaching Powder*, *Bleaching Salt*, or Tennant's Salt. It is a deliquescent salt, of a sharp, bitter taste, soluble in alcohol. It is a chloride of lime (not of calcium) mixed with hydrate of lime. It is prepared by exposing thin layers of recently slaked lime in fine powder to an atmosphere of chlorine. Chlorate of potass, prepared in a similar way, is also sold under this name. The sulphuret of lime is also used in the same way, but is not so efficacious.

Boerhaave's Astringent Powder for the ague, is prepared by mixing equal parts of alum, nutmeg, and Armenian bole.

Breeches Ball, is prepared by mixing 1 pound of Bath brick, 2 pounds of pipe clay, 4 ounces of pumice stone in powder, and 6 ounces of ox-gall, and coloring the mixture to the shade required, with ochre, umber, rose-pink, &c.

Bitter Principle of Weller, is procured by treating silk with nitric acid. It consists of carbazotic acid.

Fig 1.

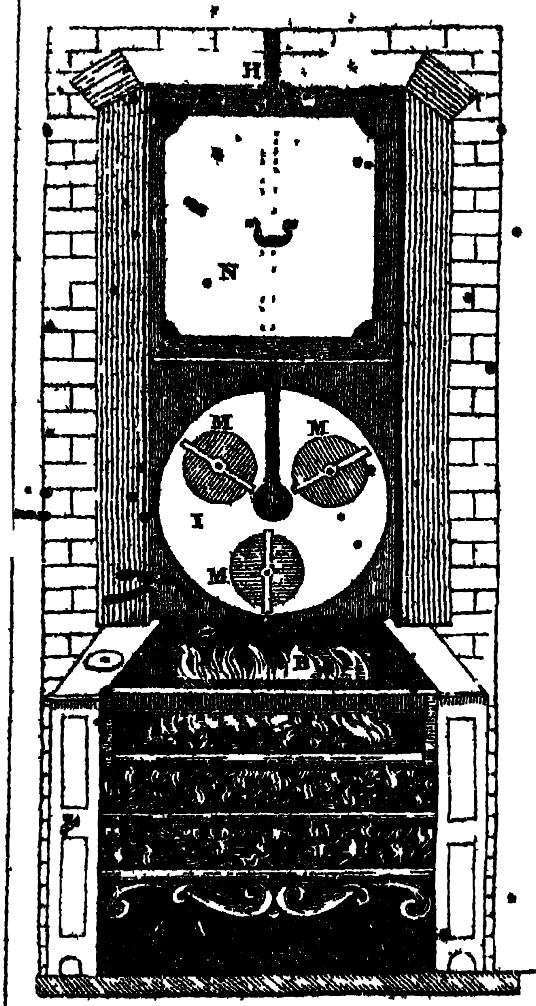
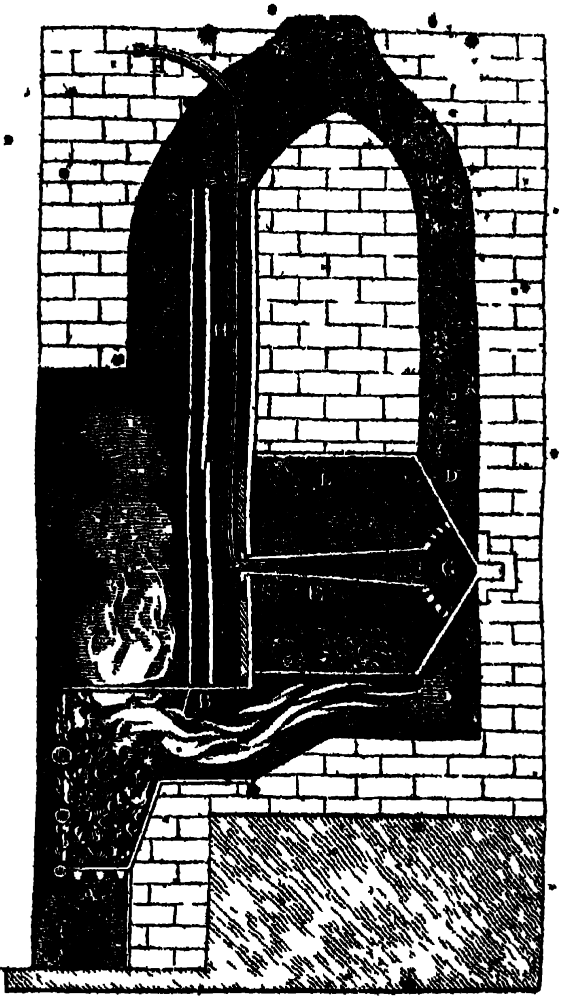


Fig. 2.



PINKUS'S DOMESTIC GAS APPARATUS

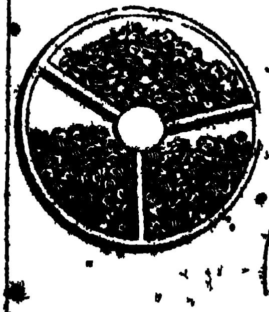


Fig. 3

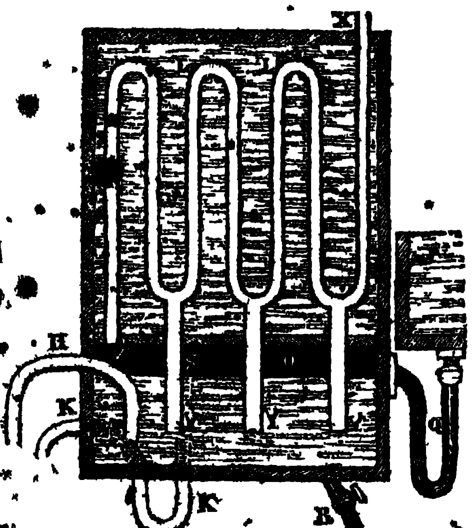


Fig. 4.

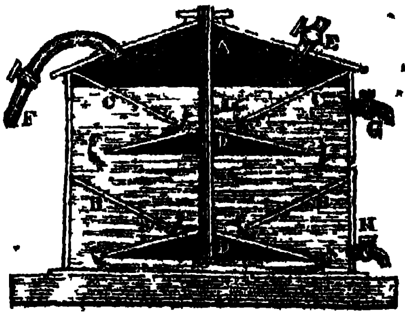


Fig 5

DOMESTIC GAS APPARATUS.

The Domestic Gas Apparatus, shown in the engraving, is an invention by Mr. Pinkus, for the manufacture of gas on so small a scale as to be adapted to private houses. An apparatus of the kind was exhibited in use for a considerable time in the Strand, and we believe the invention has been adopted in various extensive private establishments and small manufactories. Fig. 1 is a front elevation; fig. 2, a lateral section of the apparatus; fig. 3, a section of the retort; fig. 4, is a section of the condenser. In figures 1 and 2, the same letters refer to the same parts. A shows its application to a kitchen range, but is equally adapted to any other common fire-place; B B, fig. 2, is a recess or furnace built in brick at the back of the fire-place, covered in front by an iron plate, and having a flue opening in the chimney; E, fig. 2, and I, fig. 1, is a cylindrical retort, divided by two or more internal partitions, radiating from a conical pipe F, as shown in fig. 2. The retort is turned with a small rim or flange at the fore end, which fits into the plate, and the hinder end is supported by a stout pin projecting from the back of the retort, and resting in an iron socket let into the brickwork. The hinder end of the pipe F terminates in a cup or cavity G, pierced with several holes, and serving as a chamber for the gas to collect in; the pipe F is also pierced with numerous small holes, to allow the tar, as it forms, to fall through them upon the burning fuel, where it, as well as that portion which runs down the conical pipe F and the cup G, is decomposed and converted into gas. In the fore end of the pipe F is screwed a stuffing box, through which passes the pipe H, leading to the condenser. Each compartment of the retort has a door or mouth-piece M M, by which the coal, or other material for making gas, is introduced, and the door is secured by screws, the joints being either ground true or luted; N is an iron plate, sliding in grooves, and when lowered down, serving to defend the face of the retort and the pipe H from the action of the fire. Fig. 4 is a vessel divided into two parts, the lower part O, which is air-tight, containing a quantity of tar, into which the pipe H dips a few inches; it is supplied with tar from another vessel P, by means of a bent pipe Q; R is a pipe for drawing off the tar when required, and S an opening by which the tar runs down the pipe K into H, and thence into the retort. The upper division of fig. 5 contains a range of bent pipes L L surrounded by water, one end of which, V, opens into O, and the other end X leads to the gasometer; from the lower bends of these pipes short pieces Y Y descend into the tar in O, by which means the tar condensed in the pipes L L descends into O, while the gas cannot escape through the short pipes. The operation is as follows:—The retort being charged, and the doors secured, the retort is turned till the chambers are in the position shown in figs. 1 and 3; the shutter N is then let down and the fire lighted, a portion of the heat and flame from which passes through an aperture in the back of the range into the furnace B, causing, in a short time, the lower part of the retort to become red hot, and the coals or other materials in the interior to give out gas, which, collecting in the chamber G, passes through the pipes F and H to the condenser; at the same time the tar given out by the coals in the upper chambers of the retort, descends through F and G on to the burning fuel in the lower chamber, and becomes decomposed. When it is supposed that the materials in the lower compartment have given out all the gas contained in them, the retort is turned partly round, so as to bring another compartment immediately over the flame, when the gas is again given out as before. The gas, thus formed, contains tar and other impurities, from some of which it can be freed by a reduction of temperature; the pipe H is, therefore, made to dip a few inches into the tar vessel O, and through this tar the gas has to rise to enter the condenser, by which means it is divested of a portion of its impurities, and upon entering the condenser, it passes through a great length of pipe surrounded by cold water, when all the *condensable* impurities are separated, and descend into the tar vessel by the pipes Y Y. The tar, as we have before stated, returns to the retort by the pipes K and H, and is decomposed by falling on the burning coke in the retort. From the condenser the gas passes to the purifier, and thence to the gas-holder; but the method of purifying the gas, either upon a large or a small scale, forms the subject of a separate patent to Mr. Pinkus, which we shall now proceed to describe.

The purifying substances employed by Mr. Pinkus, are the chlorides of soda, or of lime. The engraving, No. 5, represents an arrangement of the purifying vessel, adapted for the use of private houses, to purify the gas as it passes from the public main to the burners. The method is as follows:—The gas, upon leaving the condenser, passes through a solution of the chlorides of soda, or of lime, which may be contained in a vessel resembling that shown in section at fig. 5, through which the gas may be made to pass, acting under a pressure of from ten to twenty inches of water, by which means it will be purified, and its obnoxious odour and bad smell removed. The structure of this vessel is easily understood, from the following short description. Fig. 5 represents a tin or iron circular vessel, closed at both ends. B B and C C are two shelves which slope downwards, and pass round the vessel. A is a pipe which extends very nearly to the bottom. D D are two circular shelves, put up and fixed to the centre pipe A. E is a pipe to fill the vessel with liquid. F the pipe to convey away the purified gas. G and H cocks to empty the vessel when requisite. In preparing the solution, the patentee directs to employ one part of chloride to about thirty-five parts of water, and when the chloride is in its most concentrated state a diluted acid, sulphuric or muriatic, may be added to the solution to assist the liberation of the chlorine gas from the lime; and the quantity of water may then be increased to forty or fifty parts, with one of the chloride.

SOLUBLE GLASS.

(Resumed from page 79, and concluded.)

Uses.—The properties of soluble glass fit it for numerous and varied applications. It has been used in the theatre of Munich as a means of safety from fire. All sorts of vegetable matter, wood, cotton, hemp, linen, paper, &c. are, as is well known combustible; but, in order that they shall burn, two conditions are requisite, an elevated temperature, and free contact of air, to furnish the oxygen necessary for their transformation into water and carbonic acid. When once set on fire, their own combustion developes the heat necessary to keep up the chemical action, provided they be in contact with air. If deprived of such contact, and made red hot, they will, it is true, yield inflammable volatile products, but the carbon which is left will not burn, as it is deprived of air, and thus the combustion will stop itself. Such is the part which all the fixed fusible salts are capable of performing, if they be, in addition, composed of substances incapable of yielding their oxygen at a low red heat, to either carbon or hydrogen. These salts melt as the vegetable matter becomes heated; they form upon it a coat impenetrable to the air, and either prevent altogether, or limit its combustion. The phosphate and borate of ammonia have such a character, but they are so readily soluble in cold water, as to be liable to objections which cannot be urged against soluble glass. Although soluble glass is of itself a good preservative from fire, it fulfils the object better when it is mixed with another combustible body in powder. In this case the solution of glass acts in the same manner as the oil of painters. The several coats have more body, become more solid, and more durable; and if the substance which is added be of proper quality, coagulate by the action of fire into a strongly adhesive crust. Clay, whiting, calcined bones, powdered glass, &c, may all be employed for this purpose; but we cannot yet say with certainty which of them is to be preferred. A mixture of clay and whiting appears to be better than either used separately. Calcined bones form, with soluble glass, a very solid and adhesive mass. Litharge, which, with the glass, makes an easily fusible mixture, does not give a product fitted for coating wood, as the mixture contracts in drying, it therefore cracks, and is easily separated. Flint glass and crude soluble glass are excellent additions. The latter ought to be exposed to the air after it is pulverized, in order to attract moisture. If it be mixed with the solution, and be then applied to any body whatever, it, in a short time, forms a coating as hard as stone, which, if the glass be of good quality, is unalterable by exposure, and resists fire admirably. The scoriæ of iron and lead, felspar, fluor, may all be employed with soluble glass; but experience alone can decide which of these substances is the best, and in what proportion they are to be employed. We should advise that the first coat should always be a simple solution of the glass; and that a similar solution be applied over coats composed of its mixture with other substances, particularly when such a coat is uneven and rough. The last named substances form a solid and durable coating, which suffers no change by exposure to the air, does not involve any great expense, and is readily applied; but, in order that it may not fail, particular care is to be taken both in preparing and employing it. In order to cover wood, and other bodies with it, the solution must be made of pure glass, for otherwise it would effloresce and finally fall off. However, a small degree of impurity is not injurious, although, after a few days, a slight efflorescence will appear; this may be washed off with water, and will not show itself a second time. When a durable covering is to be applied to wood, too strong a solution must not be employed at first; for in this case, it will not be absorbed, will not [illegible] the air from the pores, and, in consequence, will not adhere strongly. It is a good plan to [illegible] the brush several times over the same place, and not to spread the coating too thickly. For the last coats a more concentrated solution may be employed, [illegible] it must not be too thick, and must be spread as evenly as possible.—Each coat must be thoroughly dry before another is applied; and this will take, in warm, dry weather, at least twenty-four hours. After two hours the coat appears to be dry, but is still in a state to be softened by laying on another. The same inconvenience will then arise which occurs when a thick coat of a concentrated solution is applied; the coat will crack, and does not adhere. This, however, is only the case when potassa is the base of the glass, for that formed from soda does not appear to crack. In applying soluble glass to the woodwork of the theatre at Munich, 10 per cent. of yellow clay (*ochre?*) was added. After six months the coat had suffered but little change; it was damaged only in a few places where it had need of some repair. This arose from a short time only having been allowed for the preparation and application of the glass, and they were, therefore, done without proper attention. When this mode is employed for preserving a theatre from fire, it is not enough to cover the woodwork, it is also necessary to preserve the scenery, which is still more exposed to danger. None of the methods yet proposed for this purpose appears as advantageous as soluble glass, for it does not act upon vegetable matter, and completely fills up the spaces between the thread; it fixes itself in the web in such a way that it cannot be separated, and increases the durability of the fabric. The firmness which it gives to stuffs does not injure them for use as curtains, because it does not prevent them from being easily rolled. So far as the painting of scenes is concerned, the glass forms a good ground for the colors. To prevent the changes which some colors, Prussian blue and lake for instance, might undergo from the alkaline matter, it will be necessary, before painting, to apply a coat of alum, and then one of whiting.—There is no great difficulty in applying soluble glass to cloths; still this operation is not so easy as might at first be imagined. It is not sufficient to coat or dip them in the solution; they still require, after this operation, to be subjected to pressure. This object might, perhaps, be best attained by passing them between rollers plunged in the solution. When a cloth is only coated with soluble glass, and put into the fire, it will remain incandescent after it is taken out. This is not the case when it has been properly impregnated with the solution. A still better purpose is answered in this case, when litharge has been added to the solution. The stuff in drying yields to the shrinking of the mixture, and becomes inseparable from it, which is the reverse of what happens when it is applied to wood. A single part of litharge in fine powder is sufficient for fourteen parts of concentrated liquor. Soluble glass is capable of many other applications, and particularly as a cement; for this use it is superior to all those which have hitherto been employed for uniting broken glass, porcelain, &c. It may be used in place of glue or isinglass in applying the colors, although, when employed by itself, it does not make a varnish which will preserve its transparency when in contact with air.

CHANGES WHICH THE STOMACHS, O CRABS UNDERGO

A very accurate account of these changes is give[illegible] by Dr. K. E. V. [illegible], in the sixth [illegible] "Müller's Archiv." Crabs, it is [illegible] change their [illegible] and it is a very old opinion that they change their stomachs at the same time, a new stomach being formed round the old, which is digested by the recently developed organ. Baer has proved that the crab's stomach consists of two coats; one inner, which, in every respect, may be compared to a callous, horny epidermis, and which is destitute of vitality; and an outer or containing coat, transparent, but sufficiently strong and vascular. The inner coat consists of various and very curious parts, some resembling bony plates, others compared to teeth; now, at the period when the crab changes its skin, it likewise casts the inner coat of the stomach, and, on this account, this process, analogous to the moulting of birds, and to the renewing of hair in quadrupeds, is, in the crab, attended with very great constitutional disturbance, and a total interruption of the digestive function. Baer relates very accurately the changes which the stomach undergoes preparatory to the casting of its inner coat. It would be beside our present purpose to follow him in this description, however interesting. Some things he mentions are, however, specially worthy of remark; in the first place the softer parts of the old epidermis or inner coat of the stomach are very rapidly digested in the stomach, as soon as it has recovered its functions, and has, which it does quickly, formed a new lining on its inner surface. But there are other harder parts that cannot be so readily digested and dissolved, and which are otherwise disposed of. The hard and hollow bones, popularly termed the teeth, are got rid of by being discharged through the external orifice corresponding to the mouth. There are other solid plates of the epidermic portion of the stomach, which are not of a shape calculated to irritate the new and tender epidermis, and, consequently, they can be retained with impunity, and are destined to perform a new and curious function, for, according to Baer, these plates, *for* some time preparatory to the act of casting the shells, rapidly increase in weight and in solidity, so as, at the period we are speaking, they may be considered as forming considerable reservoirs of earthy matter, to be gradually dissolved and digested in the newly-lined stomach, at the very time earthy matter is required by the animal for the formation of its new shell. These plates are popularly called *crab-stones*, and, when submitted to the digestive process, soon lose their roughness, and become smooth and polished before they are entirely dissolved. These crab-stones are chiefly composed of carbonate of lime, and Baer has proved, by repeated analyses, that the fluid contents of a crab's stomach contain, at the time these stones are in them, a considerable portion of lime, carbonic acid, and muriatic acid. It is interesting to observe, that the chemical investigations of Dulk, render it highly probable that the chief solvent in the crab's stomach is the same acid which plays so important a part in human digestion and in dyspepsia, viz. *free muriatic acid*.

BOTANICAL NOTICES.

STEMS, BUDS, AND BULBS.

A STEM is that part of a plant which supports the flowers and leaves. It usually grows upwards and towards the light, but occasionally it trails along the ground, producing young plants at intervals, as in *the runner* of the strawberry, and not unfrequently within the ground, as in the couch grass, the mint, &c., already described as roots, by which name such stems are generally known.

Stems are most scientifically distinguished by their structure, whether belonging to dicotyledonous or monocotyledonous plants; those of the former class are called *exogynous* stems, increasing in size by a layer of fresh matter to their outer parts from time to time, and being hardest towards the centre. Those of monocotyledonous plants, called *endogynous*, increase by a deposit to their centre, which therefore forces the former part outwards, and they are hardest on the outside. These distinctions are, however, too difficult for the young botanist. The following more usual and obvious characters are therefore continued:—

Truncus or *Trunk*.—This is seen in trees and shrubs, and is the only kind of stem in which the most complete structure is plainly discernible. It consists of bark, wood, and pith. Upon cutting such a stem as this across, we find outside of all a very thin *skin*, called *the cuticle* or *epidermis*. When this is stripped off we find fixed within it the *true back* or *cortex*. The next coat is the *inner bark* or *liber*. All these three distinct parts are called by the general term, THE BARK; and are intended to preserve the inner portion from the injuries of drought and exposure to the weather. It is also in the inner bark that the principal sap-vessels are contained, by which the moisture that has been previously absorbed by the roots is carried upwards. Within the bark is, first, the *new wood* or *alburnum*—this is the last portion of the solid trunk which has been formed, for trees increase by a ring or coat of wood being deposited yearly under the bark. Thus, by counting correctly the number of rings seen upon a transverse section of a trunk, the age of the tree of which it formed a part may be ascertained. The alburnum, which is known among workmen by the name of *sap*, is more porous, and usually of a lighter color than the older portion. This difference of color is very often seen in those rulers which are made of lignum vitæ, where the alburnum is white, and the rest of them nearly black. Under the alburnum is the *real wood*, *heart wood*, or *lignum*, and within this, in the centre of the whole, is the *pith* or *medulla*; a porous and light body, occupying frequently the greater part of young shoots, as in the twigs of the elder tree, but by degrees becoming smaller, until in process of time it is nearly or entirely lost. Joining the pith to the bark, and running through the whole substance of the wood from the centre outwards, are various rays or flakes—these are the *medullary rays*, and constitute what is called the *silver grain*. It is seen plainly in the oak when cut into boards and polished, and adds much to the beautifully mottled appearance of mahogany, satin wood, &c. The trunk is always divided more or less—in shrubs near the ground, in trees not till some considerable distance above it—the larger and thicker divisions are called *branches* or *boughs*, and the smaller ones *twigs*, *shoots*, or *sprays*. The whole of which taken together is called *the head* of a tree. If this be cut off, the tree is said to be *a pollard*, as a pollard oak, a pollard willow, &c. If the side branches only are separated it is said to be *lopped*.

Caulis or *Stalk*.—This includes the stems of most herbs, and is an imperfect state of the former kind; for on account of its shorter duration, (herbaceous stems lasting but one year) and the usually greater rapidity of its growth, there is no distinction between new and old wood—the only bark is [illegible] and fleshy, and the pith is either very much in quantity or altogether wanting; in which latter case the stalk becomes hollow.

Stipe, is a name given to the stem of the date tree, the cocoa nut, and other species of the palm; it increases in length year by year, but not in diameter: it is knotted on the surface by the scars of old leaves; and is not formed of layers of wood, but of an irregular fibrous mass, the outside of which is exceedingly hard. The stipe is never branched, and bears leaves only at the top.

Culmus or *straw*, is a hollow jointed stem, found only in the tribe of grasses. Although these contain indeed no hard woody substance to support them, yet they are not feeble—for the materials of which they are formed, being disposed in a ring, render each stem twice the thickness it would be if solid; besides which they are further strengthened by a layer of flint upon their surface, by their solid joints, and sheathing leaves.

Scape, is a stalk which supports the flower only, as in the primrose or cowslip: if the flower stalk does not come from the root, it is not a scape but a *peduncle*, so if it supports a leaf only, it is called a leaf stalk or *petiole*.

The three last-described stems admit of little variation, but the trunk and caulis are almost endless in their differences of form, manner of growth, &c. In consistence, a stem may be either woody, herbaceous, succulent, pithy, solid, or hollow. In form, round, variously angled, winged, channelled, jointed, rough, &c. &c. In manner of growth, upright, curved, procumbent, or lying on the ground, climbing, or twining around the bodies. It may be straight or twisted, smooth, or covered with hairs, prickles, thorns, &c., while its various branches proceed from it in different directions, and more or less numerously, according to the species of the plant of which they form so considerable a part. Sometimes stems are thin as hairs—at others, strong and massive, like the most majestic columns. In the Alpine regions, almost absent; or reaching scarcely an inch in height; but in the tropical countries, growing often to the altitude of two hundred feet, while other stems, still longer, twine around them. These, clinging to each other, form garlands from tree to tree; and again extending downwards from the summits till they reach the ground, make the whole forest appear like a fleet at anchor, but decorated from mast to mast with the most vivid leaves and splendid flowers.

It has been already observed, as the first stem of a plant is formed from a bud, which is situated at the top of the embryo, called the plumule; so also every additional branch added to it by its after-growth, arises, in most instances, from a similar formed bud. If we examine the oak, ash, willow, or any other tree, in the summer time, we shall find in the bosoms or *axils* of all the leaves small scaly projections. When the leaves fall off in the autumn these will be still more apparent: in spring they swell, throw off their scales, and burst into leaves. During their summer's growth, the leaves, which are at first in a bunch, become removed from each other by an extension of their *axes* of growth: that is, by the formation of a twig or stem between them; while in the bosom of every leaf is seen a bud similar to that of the preceding season, and which in due time will grow in the same manner. It would, therefore, appear that no fresh branches can arise unless buds be first formed; yet in the heath, myrtles, and shrubs, no buds are to be seen, and in the plane tree, though evident enough in the winter season, yet in summer the buds are completely buried in the stalk of the leaf itself. The axils of the leaves, and termination of the last year's shoots, are the only parts in which buds are naturally formed; but it sometimes happens, that buds appear in other parts of the tree; as for example, if a tree be lopped, buds will appear upon the old stem, and produce new and vigorous branches—all such as these are called *adventitious* buds. Gooseberry trees, too, often spontaneously throw up *suckers*; these arise from such accidental buds being formed below the ground.

Buds, as above described, are to be considered as arising from the wood itself, and not from the bark or its vessels: thus, the branch or twig which it produces is firmly connected with the last year's wood, and the bud in general only grows so long as the connection between it and its parent twig is kept up; but this is not the case with all, for in certain plants small buds or bulbs, called by botanists *gemmæ*, are found in the axils of the leaves or on the stems, which are readily separated, and if immediately put in a situation favorable to growth their vitality continues, so that they maintain a distinct and separate existence.

Well-known instances are the bulbous toothwort and the tiger lily, along the stem of which very many gemmæ are borne. Another example of gemmæ is seen in the tree onion, where, instead of a head of flowers, and afterwards seed, is a number of small bulbs of a similar character. An examination of the bulb spoken of under the description of roots, show that these, like buds, consist of a number of scales or coats folding over each other, and shielding from injury the growing point in the centre, and which alone produces the future stem, flower, and leaves—the scales themselves decaying away when no longer wanted. It will be observed, that the solid bulb of the crocus is not of this formation—the growing point is at the top of it, and not withinside. It, however, wastes away year by year as they do, a new bulb being formed below it. As was before stated, this is called a *cormus* or swelled-out under-ground stem.

In some of the species of a particular tribe of plants, (the orchis tribe,) the stem forms a bulb above the ground, also solid; this is called a *pseudo-bulb*.

SMALL AIR BALLOONS.

For experiments in courses of natural philosophy, mechanics, and chemistry; as also for determining the currents existing in the upper regions of the air, there are required little balloons of hydrogen gas, whose small weight and ascensional power may enable them to rise to a sufficient height. The baudruche or blind gut of the ox, prepared for the use of the gold beater, is the best substance that has hitherto been used for this purpose.

For the purpose of making the small air balloons, a mould is necessary, made either of wood, or which is at once cheaper and better, of plaster of Paris. This mould is generally a hemisphere of 24, 30, or 36 inches in diameter, and is placed upon a stand or table, so that a person may walk round it. When used, it is to be carefully greased all over.

The baudruche, or prepared skin, when bought of the bladder-dealers, is in the form of [illegible] and very hard slips. In order to cover the mould, the skin is soaked in warm water for 12 or [illegible] hours;

is then spread out with great care, and applied to the mould, beginning at the top. The ragged edges, or any accidental inequalities, are to be removed with a deal of caution by a pair of cutting pincers. A second baudruche is then applied, so as to cover one-half of that applied to the mould; and then a third, also covering one-half of the second, and so on, in such manner that every part of the mould may be covered with two thicknesses of skin. Care must also be taken that the skin already on the mould be kept moist until the next layer is applied, as otherwise the baudruches would not adhere together; for this reason, a wet cloth must be kept on the skins until the whole is finished.

When the whole of the hemispherical mould is finished, a tape, well greased, is tied round the base of the hemisphere; and those pieces of skin which are left at the lower edge are rolled up and kept moist, while the hemispherical part is left to dry for a few hours: when dry, the part already made is greased, to prevent the adhesion of the skin, and is used as a mould, beginning at the bottom with the loose flaps remaining from the former hemisphere, and adding fresh skins up to the top of the hemisphere, where a short cylinder, about an inch in diameter, is placed, and the skins brought round it. To strengthen this intended opening into the balloon, the skin is here trebled, or even fourfold.

A few hours are sufficient to dry this second hemisphere, when it is to be taken off the mould, from which it parts with ease, in consequence of the grease; and in like manner the tape is withdrawn from the internal part. The nozzle of a pair of hand bellows being then applied to the cylindrical mouth, it is blown up, and being tied, a very thin coat of varnish is rubbed over the surface by means of a sponge. This being done, the balloon is turned inside out, and again blown up and varnished; after which it will hold hydrogen gas perfectly well.

A balloon of this kind, 3 feet in diameter, when well made, ought not to weigh more than 2 ounces and a half; so that, when filled with pure hydrogen gas, it ought to rise in the air, with the force of between 6 and 7 ounces.

PYROLIGNEOUS ACID, OR WOOD VINEGAR.

If a piece of green wood be introduced into an iron retort or other close vessel, the retort bedded in a common coal fire, and a receiver applied, it will be found that in proportion as the wood heats, the water which constitutes its natural juices will distil over, and drop into the receiver. This water almost immediately changes its nature, and becomes first acerb, and then sour to the taste; it comes over impregnated with a dark oil, which soon puts on the appearance of thin tar, and in fact, is such; part of the tar floats, part dissolves in the liquor; but the greater part sinks to the bottom of the liquor. Meanwhile gas, consisting of carbonic oxide, carbonic acid, carburetted hydrogen, and bicarburetted hydrogen, is generated abundantly. At length the liquor which comes over is very acid; but its acidity is in some measure disguised by the strong taste of the tar which is dissolved in the liquor, and gives it a [illegible] [illegible].

It is easy to trace the theory of these changes. The wood chiefly consists of oxygen, hydrogen, and carbon, in certain proportions, and in a certain state of combination. These elements separate during the heating of the wood, and they recombine immediately after in different proportions, and give rise to new substances. Part of the oxygen and hydrogen combine and form water. Another part of the oxygen and hydrogen combine each with a portion of carbon, and form two sets of compounds, carbonic oxide and carbonic acid, with carburetted and bicarburetted hydrogen. Another portion of the carbon and oxygen, with a very small quantity of hydrogen, then combine, and produce acetic acid. The remainder of the carbon and hydrogen, with a very small portion of oxygen, also unite and produce the peculiar tar. The water, acetic acid, and the tar, all distil over together, in the form of what is called in commerce *pyroligneous acid*. The acid which comes over towards the end of the distillation is the strongest portion; no doubt because the water which the timber contained has been at this time all volatilised.

The name given to this liquor by the French chemists was pyroligneous acid; but it was announced by Fourcroy and Vauquelin that it is not an acid *sui generis*, or of a peculiar nature, as had for some years before been supposed. They determined it to be merely acetic acid disguised by tar. But this was by no means a new discovery. Glauber had ascertained the same thing two centuries before; for in describing the carbonization of wood, he notices this acid liquor, and calls it vinegar. The fact seems not to have been generally known; for Homberg stated something similar to the French Academy in 1701; and Boyle details some experiments on a spirit drawn from box-wood, in which he at length detected an acid which "was in scent strong of vinegar, so that had I not known how it was obtained I should have suspected it to be *acetum radicatum*."

Vinegar, whether obtained by fermentation or by the distillation of wood, is a dilute acetic acid, that is, a mixture of a very concentrated, pungent, and inflammable acid called the acetic, with water in variable proportion. The water may be separated by a variety of means. Thus, if common vinegar be strongly frozen, and the vessel inverted, an unfrozen portion, in small quantity, will run out, which is acetic acid deprived of much water. If this be mixed with charcoal powder and distilled, a liquor will come over (the first portions of which should be rejected), which at a moderate degree of cold will shoot into beautiful crystals. These are acetic acid, otherwise called *radical vinegar*.

Acetic acid, when as free from water as it can be made, is a colorless liquid at ordinary temperatures, but crystallises in the cold; it has an exceedingly pungent smell, and a powerfully acid taste, amounting to actual causticity. When applied to the skin it is capable of forming a blister, and even a troublesome eschar; it also destroys warts and other excrescences. When heated so as to emit vapor, the vapor will readily catch flame from any burning body. The liquid sold under the name of *aromatic vinegar* is acetic acid, holding camphor and some essential oils dissolved. This compound was formerly known under the name of *vinegar of the four thieves*, or *thieves' vinegar*, on account of the following circumstance:—When the plague raged at Marseilles, four [illegible] [illegible] into the houses of the sick and [illegible] [illegible] [illegible] to a secret place [illegible] [illegible] and they returned to the same [illegible] [illegible] until they amassed great riches; but they were at last apprehended [illegible] [illegible] [illegible] [illegible] they [illegible] that they preserved themselves by drinking a glass of their vinegar two or three times a day, sprinkling their handkerchiefs and clothes with the same, and they were not afraid." The vinegar thus perfumed and used by the thieves was, of course, common vinegar, not acetic acid; and all that they contributed to the invention was the idea of combining the fumes of vinegar with the perfume of aromatics, and using the compound as an alexipharmic, the powers of which are very questionable.

In pyroligneous acid manufactories it is usual to prepare what are called *red liquor* and *iron liquor* for the use of calico-printers. The former is an acetate of alumine formed by mixing the acetate of lime, hereafter to be described, with common alum. By double decomposition,* acetate of alumina is formed, which remains in solution; and sulphate of lime, which, being insoluble, subsides to the bottom. This sulphate of lime is not allowed to go to waste: it is employed as the lute with which the end pieces of the retorts are cemented in, and it answers the purpose extremely well. The iron liquor is made by dissolving old iron hoops, &c. in the pyroligneous acid which has been rectified by distillation, but no further purified. In some pyroligneous acid manufactories the acid does not go through all the processes for purification that will be presently described. After being distilled from the iron retorts, the acid is rectified by a second distillation through a common still and worm; by these means a purer acid is procured; but it is far from being as pure as it is possible to obtain it. The steps by which it may be rendered almost perfectly pure are next to be described.

The apparatus and process employed for distilling pyroligneous acid are as follow:—The wood made use of for distillation is introduced into a cast-iron vessel, shaped like a long drum, but of a very large size. This vessel consists of a cylindrical body, about six feet and a half long, and four feet in diameter, having two circular end-pieces, which fit in at each end of the cylinder, and are secured there both by moveable bolts and luting. The cylinder is laid horizontally in a fire-place, the fire surrounding it along its whole length. The ends of the cylinder project a little beyond the fire-place, so that they, along with the two circular end-pieces, are always comparatively cool. From the centre of the end-piece of the cylinder springs a very wide tube intended to carry off the ignited wood, namely, the vapors of the acetic acid, the tar, the water, &c. This tube at length traverses a large cistern of water kept constantly cold, and ends in a copper worm surrounded by a refrigeratory; the water, acetic acid, and tar, are condensed in it; they are discharged in a state of mixture into a large cistern: here the liquor is allowed to separate; the great bulk of the tar subsides to the bottom. Above this lies the acetic acid and water mixed, and holding in solution as much tar as imparts a considerable degree of taste and smell. Floating on the surface of all lies a little more tar of less consistence and less specific gravity than that which has sunk to the bottom. In order to separate the acid liquor, which constitutes the middle stratum, a pump is made use of, the lower end of which plunges so far down into the acid liquor as to be but a few inches from the lower deposit of tar. When the pump is put in action it draws the acid liquor out, and at length the upper tarry surface is depressed until it joins the lower deposit of tar, when the pumping is discontinued. This is the first step towards removing the tar, and by it the chief quantity is removed. The acid liquor removed by the pump is received into the body of a large still, where it undergoes the process of distillation. This distillation is conducted slowly: the object of it is to remove another portion of the tar which is held in solution by the liquid; and if the distillation were urged by a strong heat, the separation would be much less effectual. The first product that distils over is of a peculiar nature: it is called *wood spirit*, and is kept separated, for a purpose that will be presently mentioned. The product which follows this is still a tarry vinegar; for it now holds in solution not tar but the essential oil of tar: it has still the strong taste, but by no means so strong as when first obtained from the wood. When nearly the whole of the acid has been drawn off the process is stopped; and the tar now collected in the bottom of the still is allowed to run off by a cock.

(To be continued.)

SPIRIT FROM THE MANGO.

The discovery that a very wholesome spirit, something similar to gin, could be manufactured from the mango, was made some two years ago in Grenada,—and there was some talk at the time in Jamaica about establishing a distillery there. The mode of proceeding is very simple:—A vat is as nearly filled as possible with the ripe fruit, and as much water added as will cover them. They are then allowed to remain from thirty-six to forty-eight hours, until fermentation commences, when the seeds are divested of whatever pulp may still adhere to them, and care is taken to retain the whole of the rind and pulp in the vat. Thirty-five per cent. of water is next added, and five per cent. of sugar or molasses. The whole is then allowed to ferment for five or six days, when it is transferred to the still, and the process conducted in the usual manner. The spirit thus extracted is mild, and has nothing of the pungency of new rum. It is described as strongly resembling in taste British gin; and this flavor is derived, without doubt, from the essential oil, contained in the rind of the fruit. It is free from empyreuma, and is pleasant and slightly saccharine. In Grenada, fifty gallons proof were obtained from "a very inconsiderable quantity" of the fruit; but it is to be regretted, "the quantity" had not been specified. Considering the deficiency in the staples of rum and sugar from the West Indies, for the last two or three years, this discovery may be considered of great importance in a financial point of view, since, should it become an article of export, it may in some measure compensate for the falling off of the revenue. It rests, however, with the West Indians, whether or not to avail themselves of this very valuable discovery.—The capital required for a mango distillery would be very small, while it appears to us that if the spirit were used in varnishes alone it would be a very profitable speculation.—*Belize Gazette.*

MEMORANDA.

Turpin on the cause of the Color of Agates.—The red color of Agate is owing to a number, greater or smaller, of *Protococcus Kermesinus* (one of the lower Algæ), accumulated together, or more frequently, reduced to their small red globules, (gemmules) agglomerated or coagulated, and distributed, according to certain circumstances, in the colorless structure of these silicious compounds.—By successive and comparative investigation, Turpin was led to conclude that the various colors, orange, rose, blood-red, and reddish-brown (varieties owing to more advanced growth) which are inclosed in, or which surround the translucid and colorless structure of different kinds of Agates, will be found to be owing to the presence either of red globules, uniformly mixed as in the Carnelian Agate, or *agglomerated* into small irregular clots, and distributed into circular waves, according to certain forms or conditions which existed at the time of the silicious conglomeration; or finally, though more rarely, to these small, red vegetables themselves, quite entire, and most distinctly visible with the microscope. It is impossible to find a resemblance in color and polish more striking than that which is seen in a white glass phial filled with *Protococcus Kermesinus*, when compared with a carnelian, as may be fully established by the trial.—*Turpin in Jameson's Journal.*

Tempering on Steel.—In the year 1789, Mr. Hartley obtained a patent for a mode of tempering cutting instruments of steel, by immersion in oil, heated to a regulated temperature, measured by a thermometer. This was certainly a great improvement, both in point of precision and dispatch, on the common method of heating the instrument over a flame, till a certain color, produced by a film of oxyde, appears on its surface. These colors are,

At 430° F. .. a very faint yellow for lancets.
450 .. a pale straw color for razors and surgeons' instruments.
470 .. a full yellow for penknives.
490 .. a brown for scissors and chisels for cutting cold iron.
510 .. a brown with purple spots for axes and plane irons.
530 .. a purple for table knives and large shears.
550 .. a bright blue for swords, watch springs, truss springs, and bell springs.
560 .. a full blue for small, fine saws, daggers, &c.
600 .. a dark blue, verging on black, is the softest of all the gradations, when the metal becomes fit only for pit and hand saws, which must be soft, that their teeth may bear sharpening by the file, and setting by the hammer or pliers.

On the Influence of a Low Temperature on the Infusoria.—The researches of Ehrenberg agree with those of Spallanzani, and prove *that cold is* generally fatal to Infusoria, especially to the *Rotatoria*. It is even more destructive to the living animals than to the eggs; but water, when recently thawed, may be found inhabited by individuals which have escaped death, and inclose the germs of future generations. The animals generally die after they have been encased in the ice from one hour and a quarter to two hours; but it appears that at the moment when congelation of the water takes place, each animalcule is surrounded by heat. A sudden thaw always produces a fatal effect on the Infusoria. They are found in winter at the lower surface of ice, covering ponds, &c.—[illegible] *Journal.*

Mr. Owen calculates that 200 persons, with machines, now manufacture as much cotton as 20,000,000 of men were able to manufacture without machines forty years ago, and that the cotton now manufactured in the course of one year in Great Britain would require, without machines, 16,000,000 of workmen with simple wheels. He calculates farther, that the quantity of manufactures of all sorts, at present produced by British workmen, with the aid of machines, is so great, that it would require, without the assistance of machinery, the labor of 400 millions of workmen.

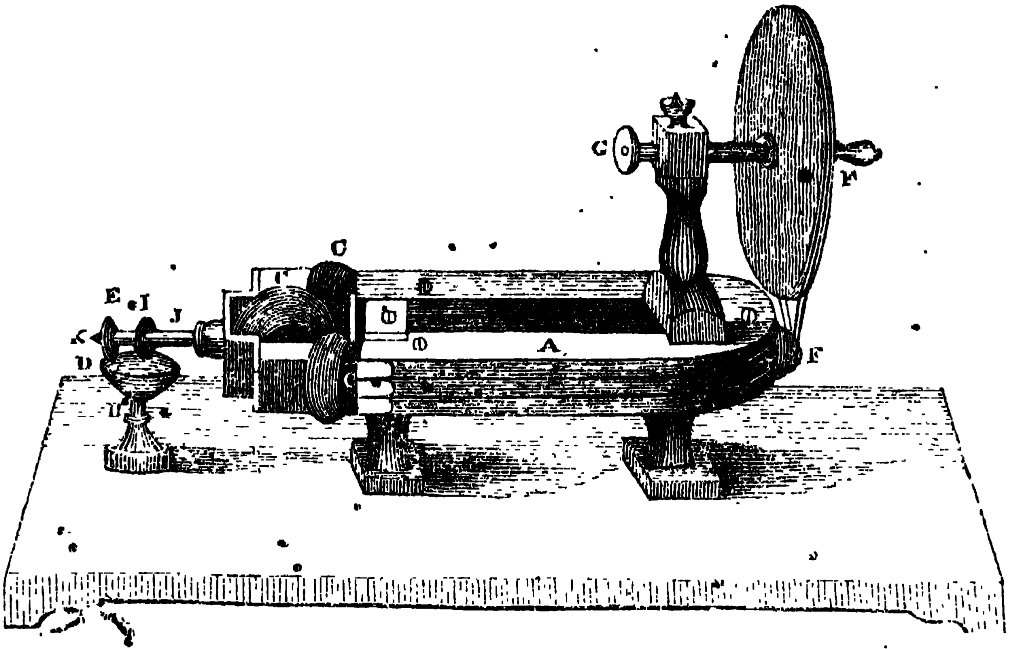
Vibration of Wires in the Air.—A gentleman of Burkil, near Basle, in Switzerland, is said to have observed, some years since, that a long wire stretched in the air gave musical tones in certain states of the weather. In consequence of this and other observations, a kind of musical barometer is described as having been constructed by Captain Hans, of Basle, in 1787. Thirteen pieces of iron wire, each 320 feet long, were extended from his summer-house to the outer court, crossing a garden; they were placed about 2 inches apart; the largest were two lines in diameter, the smallest only one, and the other about one and a half. They were on the side of the house, and made an angle of 20 or 30° with the horizon. They were stretched and preserved tight by wheels for the purpose. During certain changes of the weather, these wires make a considerable noise, resembling that of a simmering tea-urn, an harmonicon, a distant bell, or an organ. It seems to be supposed that wires placed east and west yield no sound, and that to produce the effect they must be in the direction of the meridian. In the opinion of M. Döberiener, as stated in the Bulletin Technologique, this is an electro-magnetical phenomenon.—*New Monthly Magazine.*

Natural Ice Caves.—In a memoir on some natural ice-caves, read by Professor Pictet to the Helvetic Society, in 1822, that author advanced the singular fact which was attested by the neighbouring inhabitants, that ice is formed therein more in summer than in winter, and he accounted for this effect from two concomitant causes, viz.: descending currents of air, and the cold produced by evaporation. One of the ice caves visited by Professor Pictet, is situated near the summit of Mont Vergy, in Faucigny, and is called Montarquis. To determine the fact of the absence of ice during the winter, two countrymen of the village of Sionzier, near the road to this ice cave, had the perseverance and courage to make three visits to the place during the autumn and winter, and having drawn up the following short account of their visits, it was read before the Society of Geneva:—

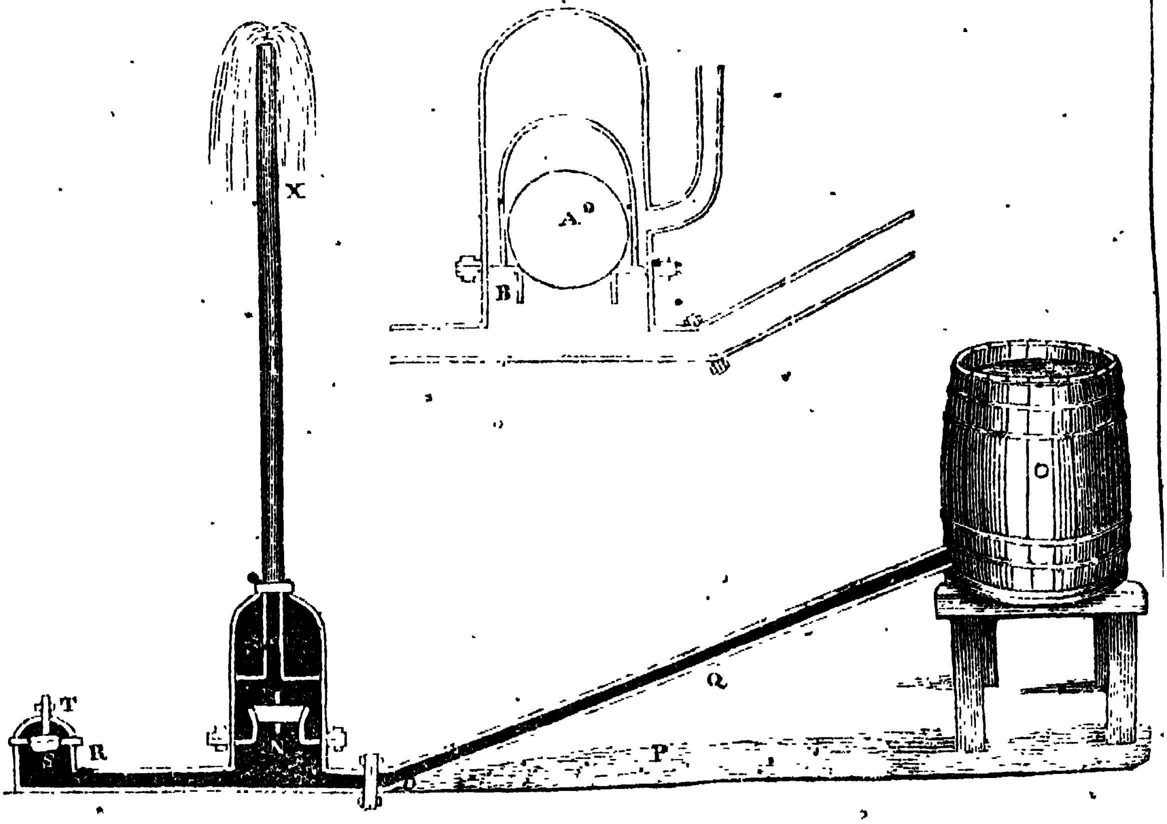
"On the 22nd of October we ascended to the ice cave of Montarquis with some difficulty, because of the first snow, and we found very little ice in columns; *it had begun to melt.*

"On the 26th of November we re-ascended to the cave; we found very little ice at the bottom of the cave, out of which there proceeded a kind of warmth.

"On the 25th of December we re-ascended to the above-mentioned ice cave with great difficulty and trouble, and were almost carried away by an avalanche. This circumstance discouraged us, but recovering from our fear we ascended to the spot. We found a moderate warmth in the cave and no ice; instead of which, where there was ice in summer, there was actually water. In winter therefore it is warm in this cavern, and in summer it is cold. The roof appears [illegible]; it appears as if there were chimnies."



SAXTON'S MAGNETO-ELECTRIC APPARATUS.



THE WATER RAM, OR BELIER HYDRAULIQUE.

SAXTON'S MAGNETO-ELECTRIC APPARATUS.

One of the most elegant, convenient, and powerful magneto electrical machines, is that of Mr. Saxton, the principle and mode of action of which has been already described, in treating of an analogous machine, invented by Mr. Clarke; this, however, has the advantage that the armature works on the ends of the poles of the magnet, instead of at the side of them, by which means the arrangement is much simplified. The machine will be immediately understood by the following short description, and the figure to which it refers.

The magnet in this apparatus is 7 inches long.—The space between the poles, from centre to centre, 2 inches. A, a steel horse-shoe magnet, consisting of three plates screwed together. B, the armature, or keeper, of soft iron. C C C, insulated helices of copper wire. D, a wooden cup for containing mercury, moveable by its stem H. E, a copper disc dipping into mercury, and communicating, by a brass socket, I, with one pole of the helices. E′, a pointed slip, or cross-bar, of copper, in contact, by a central screw, J, with the other pole of the helices, and so adjusted, that when the armature is at right angles with the poles of the magnet, the ascending point of the cross bar shall be about 1-20th of an inch above the surface of the mercury. F, a grooved wheel fixed upon the axis of the armature, B, to which rapid motion is imparted by the larger grooved wheel and leathern band F. G, a thumb-screw for adjusting the axis of the wheel, F, so as to tighten or slacken the band.

THE WATER RAM, OR BEILIER HYDRAULIQUE,

As it was called by its inventor, M. Montgolfier, of Paris, is a highly useful and simple machine, for the purpose of raising water without the expenditure of any other force than that which is produced by the momentum or moving force of a part of the water that is to be raised. The effect of this machine depends entirely upon momentum, or the new quantity of force that is generated whenever a body is put into motion; and the effect of this is so great as to give the apparatus the appearance of acting in defiance of the established laws of hydrostatic equilibrium; for a moving column of small height is made to overcome and move another column much higher than itself. The form and construction of the hydraulic ram is shown in the figure on the next page. Suppose O to represent a reservoir, or the source of a spring, which is continually overflowing and running to waste by means of a channel a few feet lower than itself, as at the level line P P, (we have shown a cask, the principle is the same, and the description as easily understood.) Instead of permitting the water to flow over the sides of O, let it be conducted to the level of P P, by means of pipes Q Q, connected with the side of the reservoir, and terminating by an orifice R, in which a conical or other valve S is placed, so as to be capable of effectually closing the pipe when such valve is drawn upwards. T is an adjustable weight fixed on the spindle of the valve S, by means of which the valve is kept down and open; any water, therefore, that is in the cistern O will flow down the pipe Q Q, and escape at the orifice R, so long as the valve remains down; but the instant it is raised and shut, all motion of the water is suspended. Thus situated, the adjustment of the weight T must take place, and by adding to, or subtracting from it, it must be made just so heavy as to be capable of sinking or forcing its way downwards against the upward pressure of the water, the force of which will depend upon the perpendicular distance from the surface of the water in O, to its point of discharge at R, (represented by the dotted line O V;) consequently, if the valve S be raised by the hand or otherwise, all motion of the water in the pipe Q Q will cease, but the instant the valve is released, it will fall down and permit the water to escape. The water, by its motion, acquires momentum and new force, and consequently is no longer equal to the column O V, to which the valve has been adjusted, but is superior to it, by which it is enabled to overpower the resistance of the weight T, and it carries the valve up with it, and closes the orifice R. This is no sooner done than the water is constrained to become again stationary, by which the momentum is lost, and the valve and weight again become superior, and fall, thus re-opening the orifice, and permitting the water to flow again; and as the pressure of the water and the weight of the valve each alternately preponderate, the valve is kept in a constant state of vibration, or of opening and shutting, without any external aid whatever. Such is the principle upon which the motion of the water in the pipe Q Q is produced; but the motion generated cannot be instantly annihilated; and it is not only of sufficient power to raise the valve S, but likewise to burst open the lower end of the pipe Q Q, unless a sufficient vent be provided, by which this accumulated force can escape. Accordingly a second valve U is placed near the lower end of these pipes, and is made to open upwards into an air vessel W, with a discharging pipe X, and consequently, whenever the valve S is closed, the water which would otherwise have flowed from the orifice R now opens the valve U and enters the air vessel, until the spring of the contained air overcomes the gradually decreasing force of the momentum, when the valve U closes, and that at S opens to permit the water to make a second blow or pulsation, and in this way the action of the machine continues incessantly, without any external aid, so long as it is supplied with water and remains in repair. A small running stream is necessary for this machine, as the water at O should be kept at one constant elevation to ensure the perfection of its action. A much greater quantity of water likewise escapes at the orifice R, between the pulsations, than can be raised in the delivery pipe X, particularly if it extend to any considerable height, for the comparative quantity of water discharged through X, and permitted to run to waste at R, must always depend upon the respective perpendicular heights of the pressing column O V, and the delivered or resisting column W X, and the rapidity of the pulsations will likewise depend upon the same circumstances. Mr. Millington, from whose *Epitome of Natural Philosophy* the above description is taken, and who has erected several of these machines in different parts of England, which gave great satisfaction, in order to show their efficacy gives the following particulars of one, which, at the time when he wrote, had been in constant use for about two years:—The reservoir O is a basin of about 10 feet square and 2 feet deep, formed partly in limestone rock, and partly in brick-work, the supply of water being from a natural spring. The pipe Q is of cast iron, 14 yards long and 2 inches in diameter. The piece at the end, containing the air vessel and the valves, is about 15 inches long; the valves 1¼ inches each in diameter, and made of brass; contents of the air vessel, about one gallon. The height from the surface of the water at O to its point of discharge at R, is 6 feet 4 inches, measured perpendicularly. The delivery pipe X is of lead, 1 inch in diameter, and proceeds horizontally under the ground 104 feet, and then rises perpendicularly to the height of 54 feet 3 inches above the discharge valve at R, where it delivers the water into a large cistern. The water is thus raised 651 inches above the surface of the spring which supplies it, and this by a fall of only 6 feet 4 inches. So circumstanced, the valve S makes about fifty vibrations, or opens fifty times in a minute, when it loses about two quarts of water, and injects nearly a quarter of a pint into the elevated cistern at each pulsation; the water lost being to that which is raised nearly as 17 to 1. This may appear a small quantity of water, but when it is recollected that the machine is at work night and day, (unless purposely stopped,) and furnishes six quarts of water every minute, this will be found to be a supply adequate to a very large household establishment. The construction above described is, however, incomplete, as, owing to the mutual incorporation which takes place between air and water, the successive quantities of water that are impelled into the air vessel would soon absorb the whole of the air contained in it, and it would cease to afford that elasticity which is indispensable to the working of the machine. This was discovered in France, by M. Montgolfier, who added an improvement to the machine by introducing a very small shifting valve, opening inwards into the lower part of the air vessel, but kept shut by a small spring. This is shown in the separate shaded figure above the last described, and represents an improved form of the air vessel. This valve is self-acting, and effectually prevents the escape of any air or water from the air vessel; but when the water is thrown back by the shutting of the valve S, it produces an instantaneous vacuum at the end of the pipe Q, upon which the shifting valve opens, and admits a sufficient quantity of the external air into the air vessel to keep it constantly replenished, and by this simple addition the water ram is rendered continuous in its action.

PYROLIGNEOUS ACID, OR WOOD VINEGAR.

(Resumed from page 87, and concluded.)

The tarry vinegar produced by this distillation is no longer red; it is now quite pale, and is even a little milky. It can never be rendered much purer by repetitions of the process; for such is the affinity of the tar-oil to the vinegar, that they will both rise in the still and come over together. The method of separation adopted is engaging the vinegar, which is the solvent of the tar-oil, by means of its affinity to an alkaline substance. The liquor is accordingly saturated either with lime or carbonate of lime.— The latter succeeds better, as it exerts no action on the tar-oil, which, therefore, to a certain extent, separates, floats, and may be readily removed by skimming. The objection to carbonate of lime is the expense. When lime is used, it not only saturates the acid, but it combines, in some degree, with the tar-oil, and forms a saponaceous compound: another portion of tar-oil separates, and floats, as in the former case. The solution of acetate of lime by saturation still further purified, and decanted off clear from any excess of lime and a little tar-oil which falls, is evaporated to dryness in an iron boiler. During the evaporation to dryness, especially towards the latter end, when the boiling process is somewhat elevated above 212°, some tarry matter is volatilised. The acetate of lime which results from this process is almost white; it is in small dry masses. This salt is introduced into a cast iron still with an earthen head. The beak of the head enters a large cask containing pure water: sulphuric acid is poured into the iron body, over the acetate of lime, and heat is applied. Vapors now arise, which are concentrated acetic acid, and which contain almost no impregnation of tar. These vapors pass over through the beak into the cask of water where they are absorbed: the water becomes more and more acid; and at length, when sufficiently impregnated, which is known by its increase of specific gravity, the *wood vinegar* is finished.

When well prepared, it has scarcely any peculiar smell or taste; it contains no foreign vegetable matter, and is, therefore, purer than that from malt, sugar, fruit or wine. It succeeds better as a pickling vinegar, because it may be concentrated to any strength. It is perfectly transparent and colorless.

The best timber for making pyroligneous vinegar is oak: but beech, ash, sycamore, and birch, answer exceedingly well; in short, every kind readily procurable is found to succeed, except elm, and the different kinds of fir. A singular circumstance is asserted by the manufacturers, namely, that elm timber, on distillation, does not afford acetic acid, but a watery liquor. Probably it affords a little acid, but so little as to be inappreciable. Dry timber affords a less abundant, but more valuable product. It should never be used in log, but cleft, as otherwise there would be much waste of fuel in permeating the large masses of wood by the heat.

Taking the average of the different kinds of timber, it may be stated, that the quantity by measure of tar obtained, is about one-twelfth of the product of the whole distilled liquor. The ratio of pyroligneous acid can scarcely be determined, it depends so much on the mode of applying the heat, the age of the timber, and various other circumstances.

Generally speaking, a gallon of the liquor, as distilled from the average charge of the retorts, affords, when saturated with lime and evaporated to dryness, about one pound of acetate of lime.— And a pound of acetate of lime, when put through the process of decomposition, by sulphuric acid, as already described, is capable of affording five pints of good house vinegar.

Instead of the apparatus just described, namely, the cylindrical retort, some manufacturers make use of the ordinary still, head, and worm; the two former parts of the apparatus being made of cast metal, and the latter of copper. Various modifications of the apparatus have been also introduced. Formerly, the inflammable gases generated during the distillation of the wood were allowed to escape into the air; at present, they are conveyed, by means of a tube springing from the retort, into the furnace where the fire is burning, and thus contribute to heat the retort and cause a considerable saving of fuel. In burning, the gas produces a flame possessed of sufficient illuminating power to render it an object of some consequence in this respect. The inflammable gas comes over chiefly during the last three or four hours of the distillation. Its illuminating power is at first very feeble; it then increases; is at its maximum towards the end; it then suddenly diminishes; in a short time it does not exceed that of the hydrogen; immediately after, the flame goes out.

There is another process for purifying pyroligneous vinegar, which has been employed, and presents a very pure acetic acid; it is thus described by Thenard:—As much chalk is added to the impure acid as can be decomposed by it at the ordinary temperature; a blackish-brown froth is formed, which is carefully removed. The liquor is then made to boil, and the saturation is finished with lime. A proper quantity of sulphate of soda is then added, which produces acetate of soda, and sulphate of lime, the latter of which being insoluble precipitates, and draws down along with it more or less tar.

When the sulphate of lime has subsided, the solution of acetate of soda is decanted off, and is evaporated to a pellicle; on cooling, it concretes into a crystalline mass. This is very impure: it is black; and is greatly impregnated with tar. It is purified by causing it to undergo the igneous fusion, re-dissolving it in water, and crystallising it at least once; during the fusion, the tar is either volatilised or carbonised, and the crystals formed are perceptibly purified. The crystals thus obtained are dissolved in water, and sulphuric acid is added: sulphate of soda is produced, which crystallises almost entirely; and the mother liquor, being distilled, affords pure acetic acid. The specific gravity of the acid prepared at Choisy is 1·057: it is capable of saturating about three-tenths of its weight of subcarbonate of soda.

The following method of purifying pyroligneous acid has been given by Berzelius: he says that it may be deprived of even the last traces of empyreumatic oil by means of animal charcoal. He found that the carbonaceous residuum left in the making of Prussian blue, when the prussiate of potash has been extracted, possesses this property to such a degree, and so effectually removes the empyreumatic taste, that the smallest quantities are sufficient; and that it is only necessary to mix the acid with the charcoal, and filter forthwith. He proved, also, that the acid thus deprived does not recover its empyreuma; for some that had been loosely corked in a bottle was, after five months, as good as ever.

Lowitz long ago showed the purifying power of common charcoal on pyroligneous acid. He says, "The so called acid of wood, which I obtained by distillation from lignum vitæ or guaiacum, was like vinegar very readily purified by distillation with charcoal, from the great quantity of empyreumatic oil which adheres to it. It thereby acquires the taste and smell of distilled vinegar; and after concentrating it to a very high degree by one of my new methods (freezing), I have brought this acid of wood, as it is termed, to crystallise in the same manner as vinegar, and have thus obtained a true glacial vinegar."

It has been ascertained that pyroligneous acid in its unpurified state possesses the remarkable and useful property of preventing the putrefaction of animal substances, and even of checking putrefaction when begun. It has been always known that smoked provisions keep better than those which have been dried, an effect which seems to depend on the impregnation of pyroligneous acid, which they receive from the smoke; for it is turf smoke that is employed, and turf by distillation in close vessels affords pyroligneous acid. The following account is given by Mr. Ramsay of experiments made by him:—A number of herrings were cleaned on the 10th of July, 1819, and, without being salted, were immersed for three hours in distilled pyroligneous acid (sp. gr. 1012). When withdrawn, they were softened, and not so firm as when first taken out of the common pickle. They were hung up in the shade. July and August were very hot months—but the herrings had no sign of putrefaction about them, but had a very wholesome smell combined with that of the acid. One of them being broiled, the empyreumatic smell was very strong. The rest, in six months, were in complete preservation.

It was afterwards found that the period of immersion had been too long. If the fish be simply dipped in acid of specific gravity 1012, and dried in the shade, it is sufficient for their preservation; and such herrings when broiled are very agreeable, and have not the disagreeable empyreumatic of the former.

A number of haddocks were cleaned, split, and slightly sprinkled with salt for six days; then being drained, they were dipped, for about three seconds, in pyroligneous acid, and hung in the shade for eight days. On being broiled they were of an uncommonly fine flavor, delicately white, and equal to the highly esteemed *Finnan* haddock. Herrings were cured in the same way as the haddocks. After being dried in the shade for two months, they were equal in quality and flavor to the best red herrings. The fish retained the shining and fresh appearance which they had when taken from the sea.

A piece of beef was dipped for one minute in pyroligneous acid (sp. gr. 1012) in July, 1819.—On March 4th, 1820; it was as free from taint as when first immersed. No salt was used in this experiment. A piece of beef was dipped at the same time in pure vinegar of specific gravity 1009. It was perfectly free from taint on the 18th of November. This experiment indicates antiseptic powers in pure vinegar; some haddocks were cured with it which remained free from taint, and, when cooked, had an insipid taste.

Dr. Jorg, of Leipzig, repeated some of these experiments, and with success. He even succeeded perfectly in making anatomical preparations, by application of pyroligneous acid.

It has been already stated, that in the second distillation of the pyroligneous acid, the first product that comes over is of a peculiar nature, and is called *wood-spirit*. This is purified by several distillations from some alkaline substance, as lime, or from oxyde of lead; and when sufficiently rectified, it assumes the appearance of a transparent and nearly colorless fluid, possessing many of the properties of alcohol. At first it was considered identical with alcohol; but there are points of difference. It is highly inflammable; and burns with a pale flame, emitting very little light. It has a peculiar penetrating smell, and a strong somewhat ethereal taste. It dissolves Indian rubber, and forms a varnish applicable to a variety of purposes. This solution of Indian rubber is also used in the manufacture of a useful and beautiful water-proof woollen cloth. Wood-spirit dissolves resins; and hence is used, by some makers of water-proof hats, as a less expensive solvent of the resins used in their process than alcohol, and equally effective.

This wood-spirit is called by chemists *pyroxilic spirit.* When rectified from muriate of lime, it is of specific gravity ·828. It boils at 150°. It burns away without leaving any residuum.

AVALANCHES.

In taking a view of the great and various phenomena of nature, we ought not to omit those tremendous elements of destruction, the avalanches, peculiar to mountainous countries, that frequently close up lakes and valleys; alter the courses of rivers, and bury under their overwhelming masses, entire districts, with their towns, villages, and inhabitants, whom they hurry into eternity without a moment's previous notice.

Mountains which are subject to the particular species of avalanche, sometimes termed a *Land-slip*, like the Righi-berg and Ross-berg, are usually composed of *Breccia* (which seems to be a conglomeration of sand and stones, more or less firmly cemented together), that is peculiarly liable to be acted upon by rains and frost, and even by droughts, being observed to open in large fissures, that soon are filled up by the melting of the snows, or by rain; and this in turn being acted upon by frost, bursts asunder and detaches huge masses that come rolling down, with a noise like thunder, bearing everything before them into the valleys beneath. This property of water expanding by freezing, is so well understood in Russia, that in some parts they avail themselves of it, as we do of gunpowder, for the blasting of rocks—all that is necessary being to bore the rocks, as in the other case, in the direction they wish it to split, and thus leave it to nature to perform the rest. The apertures are soon filled by the rains, which fall in the early part of winter, and as this season advances, the work is completed by the frost. Trees and roots, which are often of a great size there, are frequently split by the same means.

But to return to the subject, another powerful cause which operates conjointly with the others in occasioning great rents in these mountains, is found to be the accumulation of vast masses of congealed snow, that adhere to the peaks and overhanging cliffs, the weight of which is often sufficiently great to cause the mountain to separate. This was supposed to have been the case with one at the Rossberg, which took place at 5 p. m., on the 2nd of September, 1806, as it was particularly remarked of it, that there had been almost a continued fall of snow during the months of July and August preceding, succeeded by heavy rains, and subsequently by frost, when loud reports like the cracking of the mountain, had been heard at different times. The rents or fissures, however, which had, no doubt, taken place, escaped observation at the time, from the circumstance of the mountain being thickly covered with wood. On the day on which the catastrophe occurred, not more than *three* or *four* persons had any intimation of what was going to happen; those people were at work on the lower part of the mountain, but being alarmed by the increasing noises they heard, and finally by a vibration of the mountain itself, they had only time to escape with their lives, without being able to afford any warning to the villages and inhabitants that were near them. At last the mountain was seen to separate, and the whole of that part which extended between the Spitzbugal and the Steinbergerfloue, detached itself and came down, bringing with it a whole forest of trees, with a horrible crash, covering nearly two-thirds of the beautiful, smiling, and hitherto peaceful valley of Goldau, and a small part of Bonsinghen, to a depth of perhaps 200 feet, and burying under the ruins the villages of Goldau, Bonsinghen, Ober-Roethen, Unter-Roethen, and Lowertz, together with their inhabitants, formerly so celebrated in these parts for their fine appearance, their bravery, and frugal and industrious habits. *Four hundred and thirty-three* persons are known to have perished on this unfortunate occasion, including *sixteen* tourists or strangers from various parts, and *eight* individuals that were known to be there from Berne and Argovie—whilst about *five hundred and thirty* more were ruined by the entire destruction of their property; and what added to the loss of the latter, was the circumstance of some part of the *debris* having fallen into the western part of the lake of Lowertz, and forcing out the waters upon the land, swept with them, on their return back into the lake, many houses with their inhabitants, that were placed in its vicinity. The little valley of Goldau, which, before this, was considered one of the most beautiful and fertile in all Switzerland, is very narrow, having on opposite sides, the Righi, and Ross-berg, and is about two leagues in length, terminated at one end, by the lake of Zoug—and at the other, by the lake of Lowertz. Of this extent, about one league was covered over by the avalanche, and so completely did it reach across the valley, that the base of the Righi on the opposite side was covered up to some height.

Of this dreadful event, a traveller writes as follows:—"Whilst walking on the ruins of the mountain, which are heaped in horrible confusion on this spot, and, over which, a road has been cut to Art, it presents to our view masses of rubbish and rock (some as large as a house), indiscriminately piled on each other, and intermingled with fragments of trees, of which some were seen with their stems and branches fixed in the earth, and the roots in the air; and hemmed in as this valley is by mountains on each side, one seems to contemplate here the wreck of all the visible and material world around. The force, too, with which some of these immense blocks descended, must have been very great, when we consider that the height of the Ross-berg was about 3,500 feet; and it was a melancholy thing to reflect, that under the spot on which we were now treading, were concealed for ever from our view those peaceful villages, with their inhabitants, who were surprised amid their peaceful and domestic occupations, and hurried in a moment from the light of the world."

A gentleman of the town of Schwitz, in this vicinity, who collected many affecting details of this event, says—that in that town such was the uproar and noise it made, reverberated by the surrounding mountains, that the people actually thought the end of all things was arrived; and this is not to be wondered at, when we are informed that so great were the clouds of dust, of snow and of water, which it sent up, that the air was completely darkened, and the sun hid from their sight for the remainder of that day. Amongst others which he mentions, the case of a poor girl and a child are particularly remarkable. They were walking together in the garden of their cottage at the time the catastrophe happened, and the only account of it the girl could give, was, that she found herself in an instant in the situation in which she was discovered, with her body jammed in the earth, her head downwards, and her feet in the air. In this frightful position, her eyes forced from their sockets, and streaming with blood, did this poor girl remain for several hours, during which she conversed with, and endeavoured to pacify the child, which cried piteously for food, and which she found was covered over by a stone near to her, and unhurt—at first she tried to persuade it to go to sleep, and that some of the family were coming to its relief—but despairing at last of this, she encouraged it to say its prayers, and they were thus engaged together, when they were discovered by the sobbing and crying of the child, which fortunately directed some people to the spot, who had gone out from Schwitz to see if there were any left to whom they could afford succour. It is interesting to humanity to learn, that this poor girl actually survived, though with a total deprivation of sight, and a dreadful horror of the event ever afterwards. She has of often said since then, that the greatest pain she felt during the time she was covered over, was from the excessive cold in her feet, which it appears was the only part of her that was found uncovered and exposed to the air.

In various parts of Switzerland, accidents of the kind here described, are perpetually occurring, and it was only five years before, viz. in 1801, that a considerable one took place in this neighbourhood, from the Righi, near to the hamlet of Sigiker, at which time a large portion of the mountain was precipitated into the Lake of Lucerne, which repelled the waters to such a degree, that by their reflux upon the land, they swept away several houses, stabling, and saw-mills, placed at some considerable distance from its banks; by which eleven persons are said to have perished. The agitation of the waters of the Lake on this occasion, are reported to have reached even to Lucerne, a distance of, perhaps, six or seven miles, and did some damage to the shores on the opposite side of the Lake.

In point of extent and consequences, one which occurred lately in the valley of Bagnes, deserves to be mentioned, as it was attended with circumstances very peculiar. This valley being very narrow, and almost entirely occupied with the river Drance, was stopped up near its source, by an avalanche, and the river being in consequence dammed up, a vast accumulation of water had taken place, so as to form a lake of considerable size before it was discovered, owing to the retired situation of the place, and being but little frequented.—As soon, however, as it became known, it created a great sensation for the safety of the country, and the inhabitants along the whole course of that river, to where it joins the Rhone, above Martigny; and afterwards to the Lake of Geneva, where the Rhone enters the latter near to Villeneuve; a total extent of 14 or 15 leagues, and this was not without reason, considering so vast a body of water, and the force with which it would descend, if let loose suddenly from so great an elevation amongst the mountains. Public meetings of the inhabitants were instantly convened, and as the danger was pressing and hourly increasing, experienced engineers were employed to effect the making of a tunnel, by which to draw off the waters gradually; when it was supposed the impediment might be removed, and the progress of the work, as it took place, was regularly notified to the people, and signals established along the whole line, to warn the inhabitants when the danger should seem very apparent, so as to enable them to remove themselves and their stocks, to places of safety. Notwithstanding the excellence of these regulations, however, the danger could not be averted entirely, for when the work was considerably advanced, the water forced through the tunnel, blew it up, and ruptured the dam, by which the whole body of the water was unexpectedly set free, carrying away bridges, houses, inhabitants, with their cattle and goods, and, in short, everything that was opposed to it through its lengthened course towards the Lake. As the damage and loss of lives it occasioned were very great, and the particulars were published in all the newspapers at the time, we need not occupy our pages with a recapitulation; but the loss of lives would have been still greater, had it not fortunately happened at a very early hour, before the workmen had arrived to commence their work. Two of our countrymen, and their guide, who had gone up to visit the works early that morning, are said to have been the only persons who witnessed the event, and escaped, by proceeding rapidly up a precipice; but in such haste, that the horse, belonging to one of them, was lost. Certain it is, they fled in great terror to Geneva, and were the first who made the accident known there.

Another kind of avalanche is that which is composed almost entirely of congealed snow and ice, and which is so frequent about Grindelwald, Chamouny, and other places, where there are glaciers; that these valleys are constantly resounding with the noise of the falling bodies, which being re-echoed by the mountains around, make a noise like thunder; and in some confined places, the vibration which is occasioned in the air, by merely firing off a musket, will sometimes detach considerable portions of it. When any of these masses of snow are sufficiently large to block up a valley or road, which is of frequent occurrence, they become so condensed and firm, owing to their great weight, and falling from such tremendous heights, that a traveller on horse-back may pass over them in safety, without fear of sinking. The valley of Valorsine and Tete-noir, was once closed up by an avalanche of this nature, under which [illegible] Trient had worked itself a passage, forming a regular arch through its whole extent. This snow-bridge travellers had occasion to cross over on horseback more than once; and in one or two places, where the arch had fallen in, they could venture near enough to look through the openings, and see the torrent spending its rage underneath. This was in the month of May, when the sun was beginning to be powerful, and a week after its fall: but in a few days more, they said it would be impassable for about three weeks or a month, after which time the whole would disappear, and be carried off by the river.

OF GASEOUS ANALYSIS.

THIS department of chemistry, whose great importance was first shown by Cavendish, Priestley, and Berthollet, has lately acquired new value in consequence of M. G. Lassac's doctrine of volumes, his determination of the specific gravities of vapors, and sagacious application of both principles, to the developement of many combinations hitherto intricate and inexplicable.

Let us first take a general view of the characters of the different gases. Some of them are colored, others diffuse white vapors in the air; some relume a taper, provided a point of its wick remains ignited; others are acid and redden tincture of litmus; one set have no smell, or but a faint one; a second set are very soluble in water; a third are soluble in alkaline solutions; and a fourth are themselves alkaline. Some gases possess several of these characters at once.

1. The *colored gases* are nitrous acid, chlorine, the protoxide and deutoxide of chlorine. The first is red, the rest yellowish-green, or yellowish.

2. Gases producing *white vapors* in the air. Muriatic acid, fluoboric, fluosilicic, and hydriodic.

3. Gases *inflammable* in air by contact of the lighted taper. Hydrogen, subcarburetted and carburetted hydrogen, subphosphuretted and phosphuretted hydrogen, sulphuretted hydrogen, arsenuretted hydrogen, telluretted hydrogen, potassuretted hydrogen, carbonous oxide, prussine or cyanogen.

4. Gases which *re-kindle* the expiring taper. Oxygen, protoxide of azote, nitrous acid, and the oxides of chlorine.

5. *Acid gases*, which *redden* litmus. Nitrous, sulphurous, muriatic, fluoboric, hydriodic, fluosilicic, chlorocarbonous, and carbonic acid; the oxides of chlorine, sulphuretted hydrogen, telluretted hydrogen, and prussine.

6. Gases *destitute* of *smell*, or possessing but a feeble one. Oxygen, azote, hydrogen, subcarburetted and carburetted hydrogen, carbonic acid, protoxide of azote.

7. The smell of all the others is insupportable, and frequently characteristic.

8. Gases very *soluble* in *water*, namely, of which water dissolves more than thirty times its volume, at ordinary pressure and temperature. Fluoric acid, [illegible] flu[illegible] sulphu[illegible]id [illegible]monia.

9. G[illegible]olubl in *alkaline* solutions. Acids nitrous, sulphu[illegible] muriatic, fluoboric, hydriodic, fluosilicic, chlo[illegible]carbonic, chlorocarbonous; and the two oxides of chlorine, sulphuretted hydrogen, telluretted hydrogen, and ammonia.

10. *Alkaline* gases. Ammonia and potassuretted hydrogen.

Such is a general outline of the characteristics of the gases. *The great problem which now presents itself is, to determine by experiments the nature of any single gas, or gaseous mixture, which may come before us.*

We first fill a little glass tube with it, and expose it to the action of a lighted taper. If it inflames, it is one of the eleven above enumerated, and must be discriminated by the following methods:—

1. If it takes fire spontaneously on contact with air, producing a very acid matter, it is *phosphuretted hydrogen.* Subphosphuretted hydrogen, or the bihydroguret of phosphorus, does not spontaneously inflame.

2. If water be capable of decomposing it, and transforming it suddenly into hydrogen gas and alkali, which we can easily ascertain by transferring the test tube filled with it, from the mercurial trough, to a glass containing water, it is *potassuretted hydrogen.* Dr. Ure found in experiments on the production of potassium, by passing pure potash over ignited iron turnings, of which some account was published in 1809, that potassuretted hydrogen spontaneously inflamed. M. Sementini has made the same observation.

3. If it has a nauseous odour, is insoluble in water, leaves on the sides of the test tube in which we burn it, a chesnut brown deposit, like hydruret of arsenic, and if after agitation with the quarter of its volume of aqueous chlorine, a liquid is formed, from which sulphuretted hydrogen precipitates yellow flocculi, it is *arsenuretted hydrogen gas.*

4. If it has a strong smell of garlic or phosphorus, if it does not inflame spontaneously, if the product of its combustion strongly reddens litmus, and if, on agitation with an excess of aqueous chlorine, a liquor results, which, after evaporation, leaves a very sour syrupy residuum, it is *subphosphuretted hydrogen.*

5. If it has no smell, or but a faint one, and if it be capable of condensing one-half its volume of oxygen in the explosive eudiometer, it is *hydrogen.*

6. If it has a faint smell, be capable of condensing in the expl[illegible]e eudiometer one-half of its volume of oxygen, [illegible]d of producing a volume of carbonic acid equal to its own, which is ascertained by absorbing it with aqueous potash, it is *carbonous oxide*

7. If it has a faint smell, if *one* of the products of combustion is carbonic acid, and if the quantity of oxygen which it condenses by the explosive eudiometer, corresponds to twice or thrice its volume, then it is either *subcarburetted or carburetted hydrogen.*

8. If it diffuses the odour of rotten eggs, if it blackens solutions of lead, if it leaves a deposit of sulphur when we burn it in the test tube, and if it be absorbable by potash, it is *sulphuretted hydrogen.*

9. If it has a fetid odour, approaching to that of sulphuretted hydrogen, if it is absorbable by potash, if it is soluble in water, if it forms with it a liquid which, on exposure to air, lets fall a brown pulverulent hydruret of tellurium; and lastly, if on agitation with an excess of aqueous chlorine, there results a muriate of tellurium, yielding a white precipitate with alkalis, and a black with the hydrosulphurets, it is *telluretted hydrogen.*

10. *Prussine* is known by its offensive and very peculiar smell, and its burning with a purple flame.

If the gas be non-inflammable, but absorbable by an alkaline solution, it will be one of the thirteen following: muriatic acid, fluoboric, fluosilicic, hydriodic, sulphurous, nitrous, chlorocarbonous, carbonic; or chlorine, the oxides of chlorine, prussine, or ammonia. The first four, being the only gases which produce white vapors with atmospheric air, from their strong affinity for water, are thus easily distinguishable from all others. The *fluosilicic gas* is recognised by the separation of silica, in white flocculi, by means of water; and *hydriodic gas*, because chlorine renders it violet, with the precipitation of iodine.

Muriatic acid gas, from its forming with solution of silver a white precipitate insoluble in acids, but very soluble in ammonia, and from its yielding with oxide of manganese a portion of chlorine. *Fluoboric gas*, by the very dense vapors which it exhales, and by its instantly blackening paper plunged into it. *Nitrous acid gas* is distinguished by its red color. *Protoxide of chlorine*, because it is of a lively greenish-yellow hue, because it exercises no action on mercury at ordinary temperatures, and because, on bringing ignited iron or glass in contact with it, it is decomposed with explosion into oxygen and chlorine.

Deutoxide of chlorine is of a still brighter yellowish-green than the preceding, and has a peculiar aromatic smell. It does not redden, but blanches vegetable blues. At 212° it explodes, evolving oxygen and chlorine. *Chlorine* is distinguished by its fainter yellowish-green color, by its suffering no change on being heated, by its destroying colors, and by its rapid combination with mercury at common temperatures. *Sulphurous acid*, by its smell of burning sulphur. *Ammonia*, by its odour, alkaline properties, and the dense white vapors it forms with gaseous acids. *Chlorocarbonous gas* is converted by a very small quantity of water into aqueous muriatic acid, and carbonic acid, which rests above. Zinc or antimony, aided by heat, resolves it into carbonous oxide gas, while a solid metallic chloride is formed. With the oxides of the same metals, it forms chlorides, and carbonic acid, while in each case the quantity of gaseous oxide of carbon, and carbonic acid disengaged, is equal to the volumn of chlorocarbonous gas operated on. *Carbonic acid gas* is colorless, and void of smell, while all the other gases absorbable by the alkalis have a strong odour. It hardly reddens even very dilute tincture of litmus; it gives a white cloud with lime water, from which a precipitate falls, soluble with effervescence in vinegar.

If, finally, the gas be, neither inflammable nor capable of being absorbed by a solution of potash, it will be oxygen, azote, protoxide of azote, or deutoxide of azote. *Oxygen* can be mistaken only for the protoxide of azote. The property it possesses of re-kindling the expiring wick of a taper, distinguishes it from the two other gases. They are moreover characterized. First, because oxygen is void of taste, and capable of condensing in the explosive eudiometer twice its volumn of hydrogen gas; the *protoxide of azote*, because it has a sweet taste, is soluble in a little less than half its volumn of cold water, and because when detonated with its own volumn of hydrogen, we obtain a residuum, containing much azote. The two other gases are distinguished thus:—*Deutoxide of azote* is colorless, and when placed in contact with atmospherical air or oxygen, it becomes red, passing to the state of nitrous acid vapor. *Azote* is void of color, smell, and taste, extinguishes combustibles, experiences no change on contact with air, and produces no cloud with lime water.

ON BEN NUTS.

BEN NUTS are the fruit of a tree which grows in the Indies, Ceylon, and Egypt. Linnæus calls it *guilandia moringa*; but Lamarck has changed it to *moringa Zeilinica*, or *M. oleifera*. Its fruit is a three-valved pod, full of a white flesh, and a number of three-cornered seeds, the size of large peas, covered with a thin, soft, whitish-grey shell; these seeds contain a white oily kernel, of a very sweet taste.

The oil of ben is obtained by pressing these nuts: this oil is sweet, scentless, and scarcely ever becomes rank; by cold it separates into two parts, the one solid, the other liquid.

The property possessed by this oil, of not becoming rank, has made the watchmakers use the liquid portion of it for oiling the wheels and other works in watches and clocks. Nevertheless, partly on account of the difficulty of procuring good oil of ben, and partly from other motives, many watchmakers use at present the best salad oil.

The oil of ben is used by the perfumers of the countries where the tree grows, not only because of its keeping so well, but also because having no smell of its own, it does not alter that of the aromatic substance with which they impregnate it. They lay the flowers of tuberoses, jessamine, and other strong-scented flowers, which yield a little oil by distillation, in beds, in a close pewter vessel, along with carded cotton soaked in this oil; the vessel is then placed for some time in boiling water. When the oil is judged to have imbibed the scent, it is extracted from the cotton by the press. Oils thus prepared are called *huiles antiques*, as being the oldest method of preparing scented oils. But the perfumers in the north of Europe mostly imitate these oils, by adding essential oils to the best salad oil, or to nut-oil; and, in some cases, by shaking up either of these oils with spirit of wine distilled off the flowers, when the oil absorbs the aroma of the flowers and becomes scented. These substitutions render the oil of ben scarce in the countries where the tree does not grow, by diminishing the demand for it.

MISCELLANEOUS EXPERIMENTS.

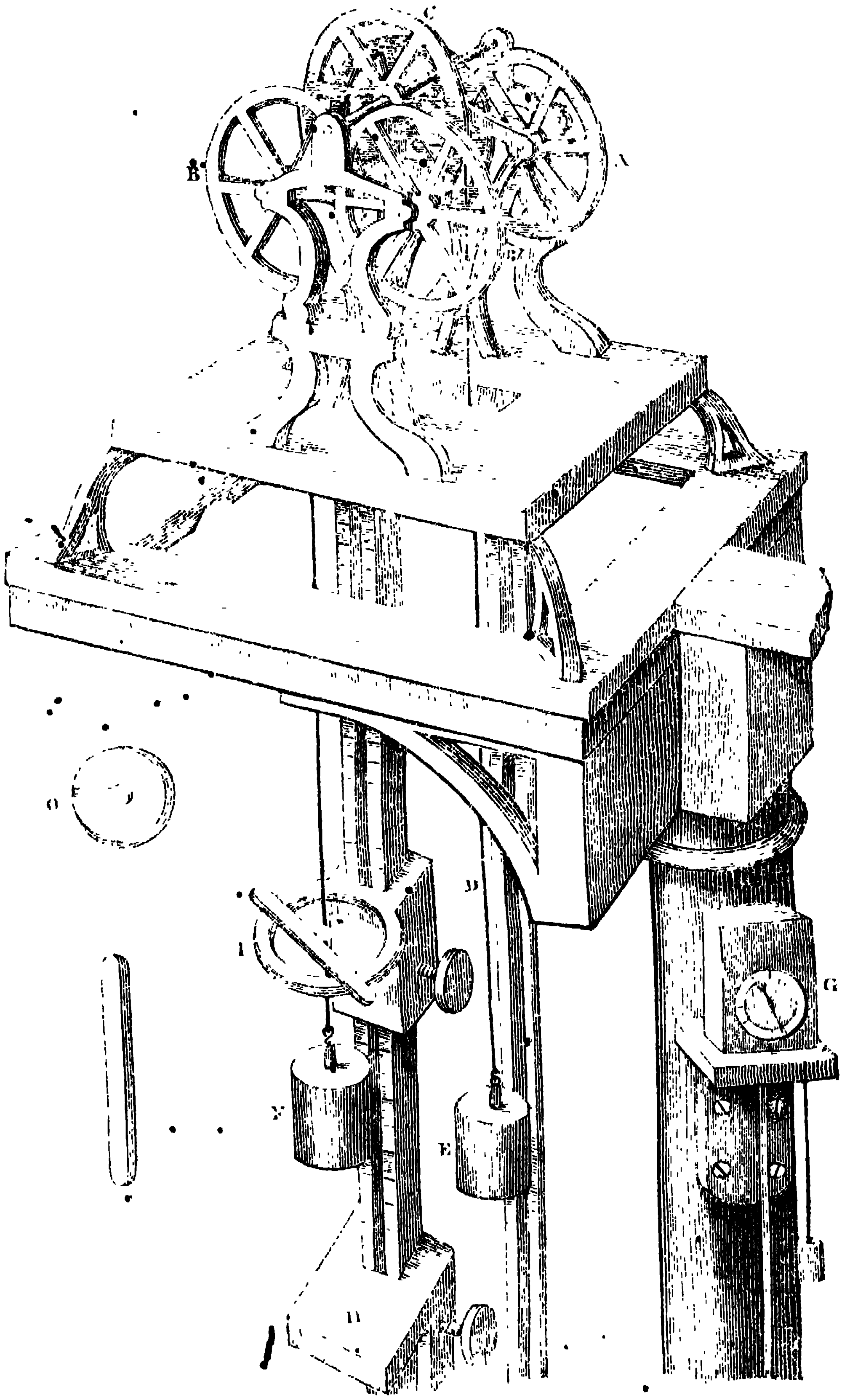
DRAW a landscape with Indian ink, and paint the foliage of vegetables with muriate of cobalt, and some of the flowers with acetate of cobalt, and others with muriate of copper. When this picture is cold it will appear to be merely an outline of a landscape, or winter scene, but when gently warmed the trees and flowers will be *displayed in their natural colors*, which they will preserve only while they continue warm. This may be often repeated.

Write upon paper with a diluted solution of muriate of copper; when dry, it will not be visible, but on being warmed before the fire the writing will become a beautiful *yellow*.

Into a large glass jar, inverted upon a flat brick tile, and containing, near its top, a branch of fresh rosemary, or any other such shrub, moistened with water, introduce a flat thick piece of heated iron, on which place some gum benzoin in gross powder.—The benzoic acid, in consequence of the heat, will be separated, and ascend in white fumes, which will at length condense, and form a most beautiful appearance upon the leaves of the vegetable. This will serve as an example of *sublimation*.

Mix a little acetate of lead with an equal portion of sulphate of zinc, both in fine powder; stir them together with a piece of glass or wood, and no chemical change will be perceptible; but if they be rubbed together in a mortar, the two solids will operate upon each other, an intimate union will take place, and a *fluid will be produced*. If alum or Glauber salt be used instead of sulphate of zinc, the experiment will be equally successful.

Curious Motion produced in Liquids by Heating and Cooling them.—Fill a large phial with water, and put into it a small quantity of powdered amber, having previously added to the water a sufficient quantity of potash, to make a solution of the same specific gravity as amber. Immerse the phial in a glass of hot water; upon which a very singular internal motion will be immediately perceived. A current of the fluid will rise up the sides of the phial, and another descend in the centre of it. Now take the phial out of the hot water, and observe the effects of its cooling. The currents will be reversed; the external one will descend, and the internal one ascend. The use of the powdered amber is to make the opposite currents into which the water is thrown, visible



ATTWOOD'S MACHINE.

ATTWOOD'S MACHINE.

FOR ASCERTAINING THE LAWS RELATIVE TO FALLING BODIES.

A REPRESENTATION of this beautiful and useful contrivance is given in the engraving. A B C is the rim of the wheel over which the thread sustaining the weights passes. The ends of the axle of this wheel rest upon the rims of two pairs of wheels, as is represented in the figure. The stand carrying the apparatus is supported by a strong pillar, and immediately under this stand is placed an upright shaft, divided into inches, half-inches, and tenths, for the purpose of measuring the rate of descent. E and F are two equal cylindrical weights suspended from the ends of the thread, which rests in a groove on the edge of the wheel A B. H is a small stage which can be screwed upon the graduated shaft, at any particular division at which it is designed to stop the descent of the weight. G is a clock, attached to the principal pillar, which beats seconds, in order to mark the rate of descent.

The weights E F are, commonly, so adjusted, that, by placing on the top of the cylindrical weight F a weight O of a quarter of an ounce, the weight F will descend through three inches in one second. Thus we have obtained an accelerating force, which is sixty-four times less than that of gravity, and yet which retains all the characteristic peculiarities of that force. In fact it is the force of gravity correctly represented in miniature.

We shall now show how this machine is applied to establish by experiment the laws which regulate the descent of heavy bodies.

Ex. 1.—To establish these laws by experiment, a ring I is provided, attached to a block D, which can be fixed by a screw to any division of the graduated shaft. A bar of metal J is also provided, weighing a quarter of an ounce, and longer than the diameter of the ring I. Let the ring I be fixed by the screw to any division of the scale, and let the stage H be so fixed, that when the weight F rests upon it, the top of the weight will be six inches exactly below the ring I. This done, let the weight F be elevated by drawing down the weight E, until the top of the weight F is exactly three inches above the ring I.—Holding the weight F in this position, let the bar J be placed upon it, and observing the beats of the clock, let the weight F commence its descent with any beat. It will be found that the stroke of the bar J on the ring I will exactly coincide with the next beat, and that the stroke of the weight F on the stage H will coincide precisely with the succeeding beat. It will be observed, that the accelerated motion of the weight F for the first second, and before the bar strikes the ring, is entirely owing to the action of the force of gravity on the bar. When the bar is taken off the weight F by the ring at the end of the first second, this cause of acceleration ceases, the action of gravity is suspended, and the weight F moves on to the stage H with the velocity which it had acquired at I. Now we have seen that this velocity was such that it moved through six inches in one second.

Ex. 2.—Again, let the stage be placed so that when the weight F rests upon it, the top of the weight will be twelve inches from the ring I, and let the weight E be depressed until the top of the weight F is twelve inches above the ring I. This done, let the bar J be placed on the weight F, and let that weight be disengaged at the moment of any beat of the clock; it will be observed that the stroke of the bar J upon the ring I, will coincide exactly with the third beat, the descent through twelve inches being made in two seconds, and that the stroke of the weight F upon the stage H will coincide precisely with the fourth beat, the weight moving through the twelve inches below the ring with the velocity it has acquired in two seconds.

Ex. 3.—Now let the stage H be once more removed, and placed so that, when the weight F stands upon it, the top of the weight will be eighteen inches below the ring I. Let the weight E be depressed until the top of the weight F is twenty-seven inches above the stage H. Let the bar J be then placed upon the weight F as before, and permitting the weight to commence its descent with the first beat of the pendulum, the bar will strike the ring I with the fourth beat, and the weight F will strike the stage H with the fifth beat. The weight, therefore, descends through twenty-seven inches with an accelerated motion in three seconds, and, at the end of that time, has acquired such a velocity, as to move through eighteen inches in a second.

Now let us review the results of these three experiments. By the first it appears, that the velocity acquired in one second is such as to make the weight F move at the rate of six inches per second. By the second experiment it appears, that the velocity acquired in two seconds is twelve inches per second; and, by the third experiment, it appears, that the velocity acquired in three seconds is eighteen inches per second. Thus the velocities acquired in one, two, and three seconds, are as six, twelve, and eighteen, which numbers are as one, two, and three. Hence the law that "the velocities acquired are as the time of acquiring them," is verified.

In the first experiment the weight fell through three inches in one second; in the second experiment it fell through twelve inches in two seconds, and in the third it fell through twenty-seven inches in three seconds. Now the numbers three, twelve, and twenty-seven, are as one four, and nine, which are the squares of one, two, and three. Hence the law that "the spaces fallen through are proportional to the squares of the times," is verified.

In the first experiment it was shown that the velocity acquired in falling through three inches, was such as would carry the weight in the same time through six inches when continued uniform and without further increase. In the second experiment it was shown, that with the velocity acquired in falling through twelve inches in two seconds, the weight F would move through twelve inches in one second, and it would, therefore, move through twenty-four inches in two seconds. In like manner, in the third experiment, it appeared that with the velocity acquired in falling through twenty-seven inches in three seconds, the weight F moved through eighteen inches in one second; and, therefore, would move through fifty-four inches in three seconds. Each of these experiments, therefore, verifies the law, that, "with the velocity which a body acquires in any time, it would, if that velocity were continued uniform, move through twice that space in the same time."

Also by the first experiment it appeared that the space fallen through in the first *second* of the descent was three inches. By the second experiment it appeared, that the space fallen through in the first two seconds was twelve inches. It consequently follows, that the space fallen through in the *second* second must have been nine inches. By the third experiment the space fallen through in three seconds was twenty-seven inches. Taking from this the space fallen through in the first two seconds, which is twelve inches, the remainder, fifteen inches, is the space fallen through in the third second. Thus the spaces described in the first, second, and third seconds of the fall are three, nine, and fifteen inches respectively, which are as the numbers one, three, and five. This verifies the law that "the spaces described by a fallen body in the successive equal intervals are as the odd integers."

Since the heights from which bodies fall are proportional to the squares of the times of the fall, and the times themselves are proportional to the velocities, it follows that the heights are proportional to the squares of the velocities. That a body may acquire a double velocity, it is requisite that it should fall from a four-fold height, and so on.

MANUFACTURE OF ALUM.

Alum is a compound substance, consisting of the earth *alumina* united with the sulphuric acid, a small portion of an alkali, together with the water of crystallization. M. Thenard's analysis of an alum, made with potash, gives the following proportions in 100 parts:—

Dry acid	31.23
Potash	7.14
Alumina	12.54
Water	46.09
	100.

But a small portion of alum is found in a native state, and that mixed with heterogeneous matters. It is principally obtained by various processes from different minerals called alum ores. The purest of all aluminous ores is the sulphuretted clay of La Tolfa, near Civita Vecchia, from which the article called *Roman Alum* is made. The ore is white, compact and hard, whence it is called petra aluminaris; it is found in veins, and is separated from the rock by blasting. The stones are taken to the calcining oven, which is simply a hole dug on a rising piece of ground about five or six feet deep, and four or five diameter, having a lateral gallery communicating with the open air, and the bottom of the furnace. On the bottom are laid faggots, and upon them the aluminous stones are skilfully placed so as to form a hollow vault; between the interstices of which the flame and smoke find a passage. The ore is considered to be sufficiently roasted when it has acquired the peculiar sweet astringent taste of alum.

The next process is that of piling the calcined stones in long beds upon a sloping floor, upon the lower side of which is a ditch of water, which extends its whole length. From this ditch the beds are frequently sprinkled with water, which, as it drains from them, runs back into the reservoir. The stones at length begin to crack and fall down, and in about forty days the whole is converted into a pasty mass overspread with a reddish efflorescence. A leaden boiler is next filled with water and made hot, when the prepared ore is stirred into it by degrees, till a solution is obtained of the requisite strength; it is then drawn off in a turbid state into another vessel, wherein it is subjected to a very gentle heat, by which the superabundant water evaporates, the earthy matter is deposited, and the liquor becomes clear. Being reduced to the point of crystallization, it is drawn off into a square wooden vessel, eight feet high by five feet wide, and constructed so as to be taken to pieces readily. In this vessel the solution becomes crystallized in a few days. The mother water is then poured out, and used in the solution of fresh alum ore. The crystals being dried are ready for sale.

At Soltafara, a few miles from Naples, is a plain, at the top of a hill covered with a white soil, which exhales sulphureous vapors, and exhibits, during the night, the emission of a pale blue lambent light, in which state it has continued from the age of Pliny to the present time. The white, clayey soil being constantly penetrated with sulphureous vapors, which together with the constant wetting by the rain and due, the alum is thus produced by nature in large quantities, but in an impure state. It is therefore collected daily, and lixiviated in large cauldrons, and afterwards crystallized in the usual manner as last described. The Abbé Mazeas procured from six pounds of the earth of the Soltafara, two and a half pounds of crystals of alums.

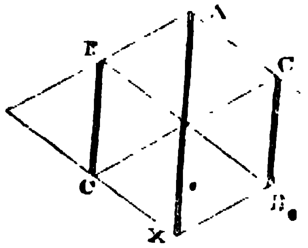
The most considerable manufactory in Great Britain, is at Hurlleet, near Paisley, on the estate of the Earl of Glasgow.* The next in magnitude is that of Whitby, an interesting account of which, and the processes, was published by Mr. Winter, in the 25th volume of Nicholson's Journal. The stratum of aluminous schistus is of great extent, and about twenty-nine miles in width. It is covered by a stratum of alluvial soil, sandstone, ironstone, shell and clay. If a quantity of the schistus be laid in a heap, and moistened with sea-water, it will take fire spontaneously, and continue to burn till the whole inflammable matter is consumed. The ore is broken into small pieces and brought to the furnace or kiln to be calcined. A bed of fuel composed of brush-wood, upon which the ore is laid and piled up in the first place to the height of four feet, when the fuel is lighted. Fresh portions of rock are afterwards added, pouring it on the pile continually until it reaches the height of from 90 to 100 feet, with its base nearly 200 feet square, and containing, in solid measurement, about 100,000 yards of ore. One hundred and thirty tons of this calcined schist produces, upon an average, one ton of alum. The calcined mineral is digested in water in large pits, from whence the liquid is drawn into cisterns, and afterwards pumped upon fresh quantities of calcined mine. The strong liquor is drawn off into settling cisterns, where the sulphate of lime, iron, and earth are deposited. In some works the liquid is boiled to aid the purification. The liquid is next poured into leaden pans, 10 feet long, 4 feet 9 wide, 2 feet 2 inches deep at one end, and 2 feet 8 at the other, for the greater convenience of emptying. In these pans the liquor is concentrated at a boiling heat, then emptied again into settling cisterns, where a quantity of the muriate of potash is added, and then allowed to settle again for the space of two hours, when it is run into coolers to be crystallized. After standing four days the mother waters are drained off, to be pumped into the pans on the succeeding day. The crystals of alum are then washed in a tub and drained. They are next put into a leaden pan with as much water as will make a saturated solution at the boiling point;—when this is effected it is run off into casks. In ten or fifteen days the casks are unhooped, and taken asunder; round the sides the alum is found in solid cakes, but, in the inner cavity, in large pyramidical crystals. This last process is called roching.

POLARIZATION OF LIGHT.

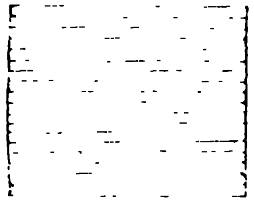
(Resumed from page 69.)

Amongst crystallized minerals, there are many possessing the property of polarizing the light transmitted through them; the most remarkable of which, however, is the tourmaline, which, from the mistaken importance and value that has been attached to it, we must briefly notice.

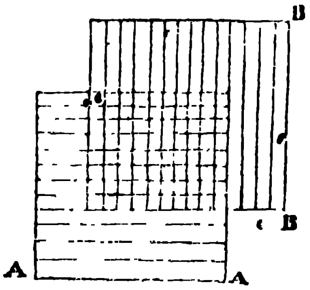
This mineral crystallizes in long prisms, whose primitive form is the obtuse rhomboid, having the axis parallel to the axis of the prism. It must be remembered, also, that the axis of crystals is not like the axis of the earth, a single line within the crystal, but a single direction through the crystal: for supposing this figure to represent a crystal of any kind, the axis of which is in the direction A X, if we divide such a crystal into four, along the lines B B and C C, each separately will have its axis A O, O X, C B, and B C, which, when united in one crystal, are all parallel: every line, then, within the crystal parallel to A X, is an axis.



Now if we cut a crystal of tourmaline of a proper kind, parallel to the axis, into thin plates of a uniform thickness (about one-twentieth of an inch), and polish each side, it possesses the property of polarizing the light transmitted through it in a remarkable manner. This figure represents one of these plates, the lines across which we may suppose to be parallel to the axis. Now, if we hold such a plate before the eye, and look at the light of the sun or flame of a candle, or any artificial light, a great portion will be transmitted through the plate which will appear quite transparent, having only the accidental color of the crystal, which, in specimens suited for these experiments, is generally brown or green; but the light so transmitted will be polarized light, and on being analysed by a second plate, which may be done by looking through both at the same time, we shall find that when the axes of both plates coincide, *i. e.* are parallel to each other, the light which has passed through the first will also freely pass through the second, and they will together appear perfectly transparent; but when one is turned round, so that the axes of each plate are at right angles (across each other) as represented in the next figure, not a ray of light will pass through,—they will appear perfecly opaque, although we may be looking at the meridian sun.



Now if we suppose the structure of the crystal to be represented by a grating, the bars of which are the axis, we may conceive that its action upon ordinary light will be to transmit such vibrations only as are performed in a plane parallel with the axis, and to stop all others. Hence the light transmitted through a single plate will be polarized, and possess exactly the same properties as the light polarized by any other means; as may be proved by analysing it by any of the means which we have been describing. But let us suppose a second tourmaline to be used; and as it is understood that, in the light which makes its way through the first tourmaline, the vibrations are parallel to the axis, all other vibrations being stopped when the axis of the second or analysing plate is perpendicular to the first, as represented in the above figure, the vibrations which have passed through the first being now perpendicular to the second, will also now be stopped by the second plate in such a position, and, as it is turned round, there will be found to be two positions in which the polarized light passes through the analysing plate, and two positions in which it will not pass through, being wholly stopped; these positions being at right angles to each other, as will be understood by the last figure, where A A is the first or polarizing plate, and B B the second or analysing plate, overlapping the first.



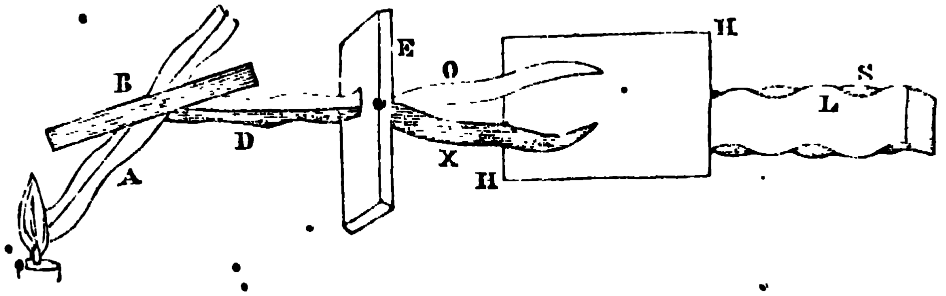
Having thus briefly considered the phenomena of polarization according to the undulatory theory, we must now, in the same way, notice the explanation which this theory also affords of the splendid phenomena of interference, which, it will readily be seen, must necessarily result from the mechanical laws of vibratory or undulatory motions, and which have consequently been a principal means of establishing the Huygenian theory, and were first originated and most ably propounded and applied by Dr. T. Young.

Suppose there are two sets of waves, propagated on the surface of a still pond of water from two points, at certain parts the waves interfere just half way between each other, so that in all those directions there will be a smooth surface, provided each set of waves is produced by precisely the same degree of disturbing force, so as to be perfectly equal and alike in every respect, and the first wave of one set exactly half a wave in advance of the first wave of the other; while, at the same time, in other directions the waves coincide and produce elevations or vibrations of double extent: in the intermediate spaces, intermediate effects will, of course, be produced.

The same laws of interference exist also in sound, which, it is well known, consists in the undulations or vibrations of the particles of air acting upon the sensorium of the ear, and producing the sensation called sound; but the consideration of these phenomena would here occupy too much space, and is not necessary to our subject. The science of acoustics furnishes experimental demonstration that two sets of undulations of air producing sound, may be made to interfere and destroy each other (or, in other words, two sounds may be made to interfere and produce silence); and as the same cause will ever produce the same effects, we may, from analogy, expect, if light consists in the undulations of an elastic medium, that two lights may also be made to interfere and produce darkness.—Paradoxical as such a thing may appear to be, the fact of the existence of such a phenomenon in light was noticed by Grimaldi, as long since as 1665.—But it is to Dr. Young that science is indebted for having first proved—and this Fresnel and Arago have since confirmed beyond all question or dispute—that certain dark bands and colored fringes are produced by the interference of light.

It is quite impossible, in a paper like this, to do justice to this great and important branch of the theory; and as we are now considering only the phenomena of colors in polarized light, the explanation already given of the interference of the undulations in water, will enable us to understand how the splendid colors are produced, according to the laws of interference, by the action of doubly refracting bodies upon polarized light.

For this purpose let D, in the annexed figure, by the polarized ray incident perpendicularly upon any double refracting crystal; the best for this purpose will be a thin film of selenite E, which is represented edgeways, and should be about the fortieth or fiftieth of an inch in thickness, and may easily be split with a knife from a large piece of the mineral; it will be quite transparent, aud break most readily into the required form. If such a film is placed in the object-holder of the polarizing apparatus attached to the hydro-oxygen microscope in certain positions, (which will hereafter be explained,) an image of the film will be projected by refraction through the analysing bundle H of glass, upon a screen in the direction L; but instead of being clear and colorless, as the crystal appears in ordinary light, its whole figure will be covered with the most brilliant colors, and, if of a perfectly uniform thickness throughout, it will be of a perfectly uniform color throughout; but if of different thicknesses, it will be of different colors, varying and changing with every degree of thickness, no matter how minute or imperceptible by any other means of observation, or the most powerful microscopic examination. Polarized light exhibits a different tint for every variation, but all of the most brilliant description. At the same time a second image will be reflected from the analysing bundle H, and can be received upon a second screen in the direction S, the colors of which will be equally brilliant, but complementary to the other reflected rays.



Thus, supposing we have a film of a uniform thickness, giving in the refracted image L a red color, then the reflected image S will be green.—The same thing will take place if the film is of different thicknesses giving different colors, as every tint has its complimentary color, and those of one image will always be complementary to the other; that is, if blended together or superposed, will make white light.

Now, if the film is made to turn round in such a manner that the points or angles may follow each other and be alternately uppermost, the polarizing and analysing parts of the apparatus remaining stationary, there will be found certain positions in which the film will have no action upon the polarized light D passing through it: these positions are when either of the cross lines, A B or C D, is parallel to the plane in which the vibrations of the polarized ray are supposed to take place.

In such positions the light passes through the crystal without suffering any change. This is proved by causing the analysing bundle of glass H H to revolve, the selenite remaining stationary;—when it will be seen that at each quarter of a circle the light will be alternately reflected, and transmitted or refracted in just the same way that it is when the selenite is removed; as we have previously noticed in explaining the action of the analysing bundle of glass.

As the film is turned round, it will be alternately in four different positions. Hence these lines in the selenite A B and C D are called neutral axis; because, in the positions described, it exerts no action upon the light passing through it; while, in the intermediate positions, it does alter the character of the light, and in which all the splendid phenomena of colors are seen.

Let us now suppose the film to be turned from its first position: as soon as it begins to move, the two images seen at L and S will begin to exhibit the most brilliant colors, which will increase in brightness until the film reaches one quarter round, where they will be at their maximum or greatest brilliancy; and when L is red, S will be green; or if L is blue, S will be orange, &c. &c. But, as the film turns, the colors will fade; till, having reached the next quarter, where they will be at their minimum or nothing, there being no action exerted by the film in such a position; but, as soon as it has passed by, the colors begin again to return, till it has reached the fourth position, where they are again at their maximum. The same thing will occur at every quarter of a circle; and, in continuing the revolution of the film, we shall find four positions in which the film exerts a peculiar action upon the polarized light passing through it.

Now, to understand how these colors are produced by the interference of the undulations of the light, let the film E be placed in the polarizing apparatus, in such a position that the two neutral axes A B and C D are inclined 45° on each side of the plane of vibrations of the polarized light, or perpendicular, and of such a thickness as to give a red image at L, and a green one at S. If the analysing bundle H H is now removed, the image will still be seen at L, but perfectly clear, not having the least appearance of color. It is evident, then, that the analysing part of the apparatus is equally necessary for the production of colors. Let us, however, first notice what the action of the selenite E is in such a position upon the polarized light passing through it. Now, being a doubly refracting crystal, when its neutral axes are thus inclined, the light passing through it will be doubly refracted; and, although not perceptible to the eye by ordinary observation from the extreme minuteness of the separation in so thin a film, yet, from this property which we know it possesses, it is nevertheless divided into two equal portions or sets of waves, the vibrations of one being parallel to the neutral axis A B, and the vibrations of the other parallel to the axis C D, and, consequently, both inclined 45° to the perpendicular, as shown at O X: O we may call the ordinary ray, and X the extraordinary ray.

But in the passage of the two rays through the crystal, they have traversed it in different directions, with different velocities; one of these sets of waves will, therefore, on emergency, be retarded and lie behind the other; but, being polarized in different places, cannot interfere. To cause them to interfere and exhibit the phenomena of colors, their planes of polarization or vibration must be made to coincide. For this purpose, let the analysing bundle of glass be placed as at H H, in which position the vibrations of both the ordinary and extraordinary rays O and X are each inclined 45° to a plane perpendicular to the plane of reflection, and, consequently, that vibrations in a beam of ordinary light, inclined at angles between the perpendicular and horizontal planes, are divided into two portions, one of which is reflected, and the other transmitted or refracted; so now again, the same effect will, of course, take place, and the vibrations or waves of the reflected half S of the ordinary ray O, will be in a plane parallel to the plane of reflection of H H, and the waves of the reflected half L of the extraordinary ray X, will also be in the same plane.—Here, then, we have two sets of waves originating from the same vibrations in the polarized ray D brought into the same plane, and, consequently, now possessing all the conditions necessary for interfering with each other; and the same also in the two transmitted portions.

The colors of the images at L and S produced by this interference will depend upon the interval of retardation of one of the rays within the medium E, which, of course, will vary with its thickness. When this thickness is such as to cause the interval of retardation to amount to half a wave in the reflected rays K and L, they will interfere half way between each other, and so far destroy each other as to produce in the image at L the black of the first order, seen by reflection, in Newton's "Table of Colors;" while, in the transmitted rays, the waves being in opposite phases of vibration, will coincide and exhibit in the image S, the white of the same order seen by transmission. When the thickness is such as to cause an interference in intermediate degrees, intermediate effects or colors will be produced;—consequently, when there is exhibited at L any one of the colors in Newton's Table seen by reflection, the image at S will always exhibit the complementary color seen by transmission, the waves of one being always in opposite phases of vibration to the waves of the other.

And we shall find, as the film of selenite is made to revolve, the bundle H H remaining stationary, that it will produce one color only at L, appearing and disappearing alternately as it passes through them, and the same with the complementary color at S. But if the film is fixed in any of the positions in which it gives the brightest color, and the bundle of glass H H, made to revolve, two colors will be seen both at L and S, which change alternately at each quarter of a circle; thus, when H H is in one position, and the image at L is red, and S green; when H H has turned round 90°, L will be green, and S red; at 180° L will be again red, and S green, and at 270° L will be again green, and S red.

These, and all the splendid phenomena of colors in polarized light, will readily be seen to be simple consequences resulting from transversal vibrations; for, when a single wave or vibration in any one plane, as at D, is divided or resolved into two at right angles to each other, one will, of necessity, be half a wave behind the other, the two being the opposite halves of the same in D; and as each of these, O and X, is again divided or resolved into two others, there will be four waves or vibrations produced from the original one. Two of them in one plane must, of necessity, coincide or conspire, while the two in the other plane are opposed.

The colors produced by the interference in one plane have been shown by Fresnel to correspond to the amount of retardation within the crystal, and that in the other plane to be due to the same amount of retardation augmented or diminished by half a wave, and, consequently, complementary to the former.

In this brief notice of polarized light, the explanation is confined to the phenomena exhibited by a single plate or film of selenite; the colors of which we have seen, vary with its thickness. With this single crystal, then, numerous splendid and beautiful effects may be produced, simply by procuring different thicknesses for giving different colors, and so arranging them upon a plate of glass as to represent different subjects; such as painted windows, bunches of flowers, fruits, and other figures. These, in ordinary light, will be perfectly transparent; but, when viewed in polarized light, will exhibit the most gorgeous coloring, and may be made to undergo the most extraordinary changes, by simply causing the analysing part of the apparatus to revolve. If single plates of selenite, or any doubly refracting crystal of considerable thickness, be ground away on one edge so as to give them a wedge shape, they will present bands or fringes composed of all the colors of Newton's Table, arising from the various thicknesses which such a shape possesses, or by grinding a concavity in a similar plate, a number of concentric rings are produced. Thus it will be seen a variety of forms may be given, producing a variety of effects; these, and a thousand more, such as the small crystals produced by evaporating single drops of solutions of acetate of zinc, chlorate of potass, sulphate of soda, oxalic acid, oxalate of ammonia, and many others, may be exhibited by means of the polarizing apparatus adapted to the hydro-oxygen microscope.—This apparatus will be described in the next paper on the subject.

(To be continued.)

ESSENTIAL OR VOLATILE OILS.

The volatile oils occur in every part of odoriferous plants, whose aroma they diffuse by their exhalation; but in different organs of different species. Certain plants, such as thyme and the scented *labiatæ*, in general contain volatile oil in all their parts; but others contain it only in the blossoms, the seeds, the leaves, the root, or the bark. It sometimes happens that different parts of the same plant contain different oils; the orange, for example, furnishes three different oils, one of which resides in the flowers, another in the leaves, and a third in the skin, or epidermis of the fruit. The quantity of oil varies not only with the species, but also in the same plant, with the soil, and especially the climate; thus in hot countries it is generated most profusely. In several plants, the volatile oil is contained in peculiar orders of vessels, which confine it so closely that it does not escape in the drying, nor is dissipated by keeping the plants for many years. In other species, and particularly in flowers, it is formed continually upon their surface, and flies off at the moment of its formation.

Volatile oils are usually obtained by distillation. For this purpose the plant is introduced into a still, water is poured upon it, and heat being applied, the oil is volatilized by the aid of the watery vapor, at the temperature of 212°, though when alone it would probably not distil over unless the heat were 100° more. Most of the essential oils employed in medicine and perfumery are extracted by distillation from dried plants; only a few, such as those of the rose and orange flower, are obtained from fresh or succulent salted plants. When the mingled vapors of the oil and water are condensed into the liquid state, by the refrigerator of the still, the oil separates, and either floats on the surface or sinks to the bottom of the water. Some oils of a less volatile nature require a higher heat than 212° to raise them in vapor, and must be dislodged by adding common salt to the water, whereby the heat being augmented by 15°, they readily come over. If in such distillations too much water be added no oil will be obtained, because it is partially soluble in water; and thus merely an aromatic water is produced. If on the other hand too little water be used, the plant may happen to adhere to the bottom of the still, get partially charred, and thus impart an empyreumatic odour to the product. But as the qaulity of water distilled depends less upon the quantity employed, than upon that of the surface exposed to the heat, it is obvious that by giving a suitable form to the still, we may get rid of every inconvenience. Hence the narrower and taller the alembic is, within certain limits, the greater will be the proportion of oil relative to that of the aromatic water, from like proportions of aqueous and vegetable matter employed. Some place the plants in baskets, and suspend these immediately over the bottom of the still under the water, or above its surface in the steam. But the best mode is to stuff an upright cylinder full of the plants, and to drive down through them, steam of any desired force; its tension and temperature being further regulated by the size of the outlet orifice leading to the condenser. The cylinder should be made of strong copper, tinned inside, and encased in the worst conducting species of wood, such as soft deal or sycamore.

The distillation is to be continued as long as the water comes over of a milky appearance. Certain plants yield so little oil by the ordinary processes, notwithstanding every care, that nothing but a distilled water is obtained. In this case, the same water must be poured upon a fresh quantity of the plants in the still; which being drawn over, is again to be poured upon fresh plants; and thus repeatedly, till a certain dose of oil be separated. This being taken off, the saturated water is reserved for a like distillation.

The refrigeratory vessel is usually a worm or serpentine plunged in a tub of water, whose temperature should be generally cold; but for distilling the oils of anise-seed, fennel, &c., which become concrete at low temperatures, the water should not be cooler than 45° Fahr.

The liquid product is commonly made to run at the worm end into a vessel called an Italian or Florentine receiver, which is a conical matrass, standing on its base, with a pipe rising out of the side close to the bottom, and recurved a little above the middle of the flask, like the spout of a coffee-pot. The water and the oil collected in this vessel soon separate from each other, according to their respective specific gravities; the one floating above the other. If the water be the denser, it occupies the under portion of the vessel, and continually overflows by the spout in communication with the bottom, while the lighter oil is left. When the oil is the heavier of the two, the receiver should be a large inverted cone, with a stopcock at its apex to run off the oil from the water when the separation has been completed by repose. A funnel, having a glass stopcock attached to its narrow stem, is the most convenient apparatus for freeing the oil finally from any adhering particles of water. A cotton wick dipped in the oil may also serve the same purpose by its capillary action. The less the oil is transvased the better, as a portion of it is lost at every transfer. It may occasionally be useful to cool the distilled water by surrounding it with ice, because it thus parts with more of the oil with which it is impregnated.

There are a few essential oils which may be obtained by expression, from the substances which contain them; such as the oils of lemons and bergamot, found in the pellicle of the ripe fruits of the *citrus aurantium* and *medica*; or the orange and the citron. The oil comes out in this case with the juice of the peel, and collects upon its surface.

For collecting the oils of odoriferous flowers which have no peculiar organs for imprisoning them, and therefore speedily let them exhale, such as violets, jasmine, tuberose, and hyacinth, another process must be resorted to. Alternate layers are formed of the fresh flowers, and thin cotton fleece or woollen cloth-wadding, previously soaked in a pure and inodorous fat oil. Whenever the flowers have given out all their volatile oil to the fixed oil upon the fibrous matter, they are re-placed by fresh flowers in succession, till the fat oil has become saturated with the odorous particles. The cotton or wool wadding being next submitted to distillation along with water, gives up the volatile oil. Perfumers alone use these oils; they employ them either mixed as above, or dissolve them out by means of alcohol. In order to extract the oils of certain flowers, as for instance of white lilies, infusion in a fat oil is sufficient.

Essential oils differ much from each other in their physical properties. Most of them are yellow, others colorless, red, or brown; some again are green, and a few are blue. They have a powerful smell, more or less agreeable, which immediately after their distillation is occasionally a little rank, but becomes less so by keeping. The odour is seldom as pleasant as that of the recent plant. Their taste is acrid, irritating, and heating, or merely aromatic, when they are largely diluted with water or other substances. They are not greasy to the touch, like the fat oils, but, on the contrary, make the skin feel rough. They are almost all lighter than water, only a very few falling to the bottom of this liquid; their specific gravity lies between 0·847 and 1·096; the first number denoting the density of oil of citron, and the second that of oil of sassafras. Although styled volatile oils, the tension of their vapor, as well as its specific heat, is much less than that of water. The boiling point differs in different kinds, but it is usually about 316° or 320° Fahr. Their vapors sometimes render reddened litmus paper blue, although they contain no ammonia. When distilled by themselves, the volatile oils are partially decomposed; and the gaseous products of the portion decomposed always carry off a little of the oil. When they are mixed with clay or sand, and exposed to a distilling heat, they are, in a great measure, decomposed; or when they are passed in vapor through a red-hot tube, combustible gases are obtained, and a brilliant porous charcoal is deposited in the tube. On the other hand, they distil readily with water, because the aqueous vapor, formed at the surface of the boiling fluid, carries along with it the vapor of the oil produced in virtue of the tension which it possesses at the 212th deg. Fahr. In the open air, the volatile oils burn with a shining flame, which deposits a great deal of soot. The congealing point of the essential oils varies greatly; some do not solidify till cooled below 32°, others at this point, and some are concrete at the ordinary temperature of the atmosphere. They comport themselves in this respect like the fat oils; and they probably consist, like them, of two different oils, a solid and a fluid; to which the names *stearoptène* and *eleoptène*, or stearessence and oleiessence, may be given. These may be separated from each other by compressing the cooled concrete oil between the folds of porous paper; the stearessence remains as a solid upon the paper; the oleiessence penetrates the paper, and may be recovered by distilling it along with water.

When exposed to the air, the volatile oils change their color, become darker, and gradually absorb oxygen. This absorption commences whenever they are extracted from the plant containing them; it is at first considerable, and diminishes in rapidity as it goes on. Light contributes powerfully to this action, during which the oil disengages a little carbonic acid, but much less than the oxygen absorbed; no water is formed. The oil turns gradually thicker, loses its smell, and is transformed into a resin, which becomes eventually hard. De Saussure found that oil of lavender, recently distilled, had absorbed in four winter months, and at a temperature below 54° F., 52 times its volume of oxygen, and had disengaged twice its volume of carbonic acid gases; nor was it yet completely saturated with oxygen. The stearessence of anise-seed oil absorbed at its liquefying temperature, in the space of two years, 156 times its volume of oxygen gas, and disengaged 26 times its volume of carbonic acid gas. An oil which has begun to experience such an oxidizement is composed of a resin dissolved in the unaltered oil; and the oil may be separated by distilling the solution along with water. To preserve oils in an unchanged state, they must be put in phials, filled to the top, closed with ground glass stopples, and placed in the dark.

Volatile oils are little soluble in water, yet enough so as to impart to it by agitation their characteristic smell and taste. The water which distils with any oil is in general a saturated solution of it, and as such is used in medicine under the name of distilled water. It often contains other volatile substances contained in the plants, and hence is apt to putrefy and acquire a nauseous smell when kept in perfectly corked bottles; but in vessels partially open, these parts exhale, and the water remains sweet. The waters, however, which are made by agitating volatile oil with simple distilled water, are not apt to spoil by keeping in well-corked bottles.

The volatile oils are soluble in alcohol, and the more so the stronger the spirit is. Some volatile oils, devoid of oxygen, such as the oils of turpentine and citron, are very sparingly soluble in dilute alcohol; while the oils of lavender, pepper, &c. are considerably so. De Saussure has inferred from his experiments that the volatile oils are the more soluble in alcohol, the more oxygen they contain.— Such combinations form the odoriferous spirits which the perfumers incorrectly call waters, as *lavender water*, *eau de Cologne*, *eau de jasmin*, &c. They become turbid by admixture of water, which seizes the alcohol, and separates the volatile oils.— Ether also dissolves all the essential oils.

These oils combine with several vegetable acids, such as the acetic, the oxalic, the succinic, the fat acids (stearic, margaric, oleic,) the camphoric, and suberic.

With the exception of the oil of cloves, the volatile oils do not combine with the salifiable bases — They have been partially combined with caustic alkali, as in the case of Sturkey's soap. This is prepared by triturating recently-fused caustic soda in a mortar, with a little oil of turpentine, added drop by drop, till the mixture has acquired the consistence of soap. The compound is to be dissolved in spirits of wine, filtered, and distilled. What remains after the spirit is drawn off, consists of soda combined with a resin formed in the oil during the act of trituration.

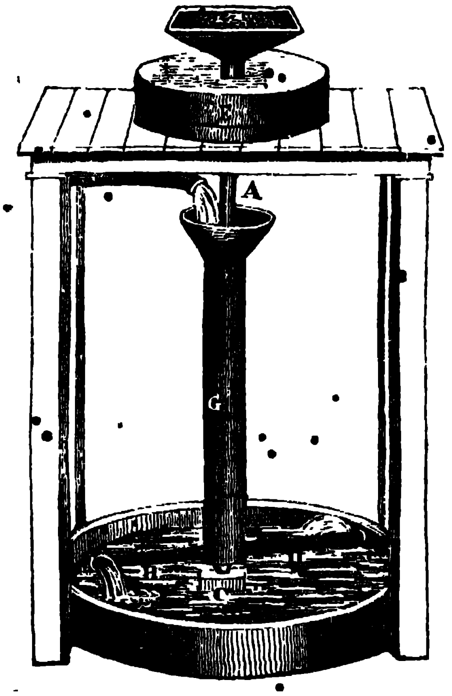
The volatile oils in general absorb six or eight times their bulk of ammoniacal gas; but that of lavender absorbs 47 times.

The essential oils dissolve all the fat oils, the resins, and the animal fats.

In commerce these oils are often adulterated with fat oils, resins, or balsam of capivi dissolved in volatile oil. This fraud may be detected by putting a drop of the oil on paper, and exposing it to heat. A pure essential oil evaporates without leaving any residuum, whilst an oil mixed with any of the above substances leaves a translucent stain upon the paper. If fat oil be present, it will remain undissolved, on mixing the adulterated essential oil with thrice its volume of spirit of wine of specific gravity 0·840.— Resinous matter mixed with volatile oil is easily detected, being left in the alembic after distillation. Oil diluted with spirit of wine, forms a milky emulsion on the addition of water; the alcoholic part is absorbed by the water, and the oil afterwards found on the surface, in a graduated glass tube will show by its quantity the amount of the adulteration.

(To be continued)

Fig. 1.



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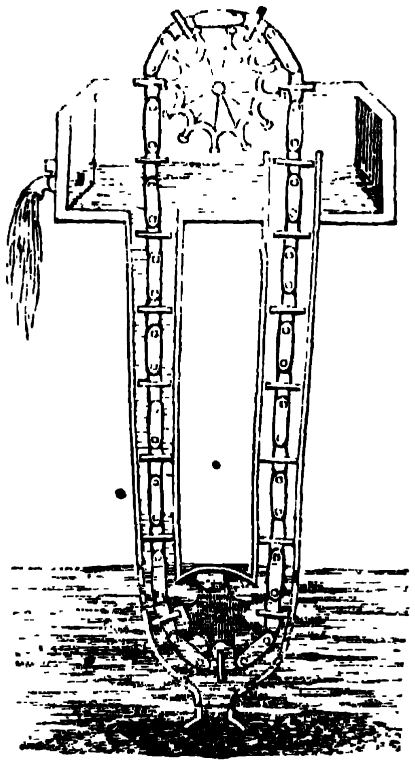
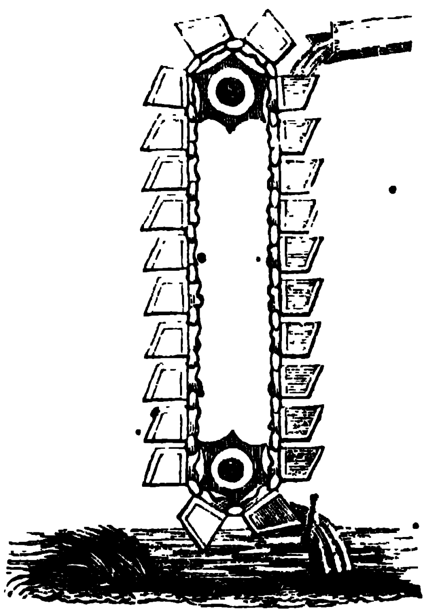


HYDRAULIC ENGINES.



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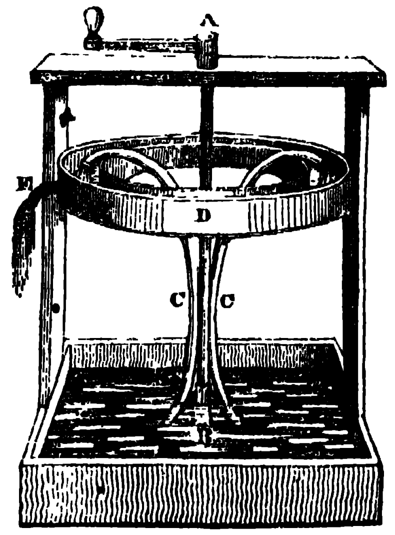
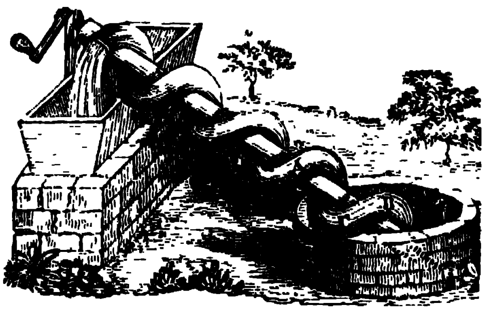


3.

HYDRAULIC ENGINES.

(Resumed from page 9.)

Archimedes's Screw.—Is represented and described as follows:—A is a hollow pipe, coiled around a cylindrical axis; which axis is inclined at an angle with the ground, and supported at each end upon pivots, the upper pivot being furnished with a handle. When this is turned round, the lower end of the pipe dips into the water in the well below, and turning upwards directly scoops up some of the water. When the end points up, the part B will become lower than it, therefore the water will fall to B. Another half turn of the handle brings C to the lowest point, and the first water will occupy that part of the tube; at the same time more water will be scooped up at the end. In a number of turns of the handle, equal to that of the coils of the tube, the first water will reach, and flow out at the top; and from that time a flow will take place at every revolution of the machine.



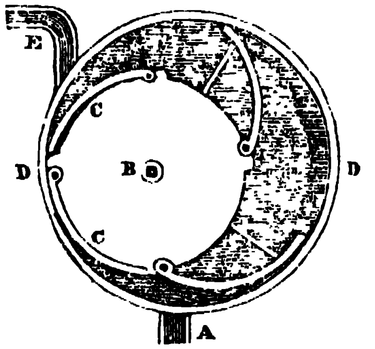
Barker's Centrifugal Mill.—This valuable instrument derives its power from the force acquired from a stream of water rushing from two holes, so placed near the ends of the arms of a moveable spindle as to throw the water on each side, and thereby to occasion a counter action against the arms, propelling them, and whatever may be attached to them in a contrary direction. Suppose A in the cut to represent a funnel connected with the hollow spindle G, this rests at the bottom on a pivot C, and bears a shaft above, which is connected with one of the millstones E. The hollow part G is terminated by the two hollow arms B B, which arms have holes, as represented. A stream of water flowing into A will fall down into G, and fill the arms B B, at length rushing out of the holes. The air will offer such a resistance to the issuing of the water, that the arms, together with the other moveable parts, will revolve rapidly.—*See fig.* 1.

Bucket Engine.—A substitute for an over-shot water wheel, and far superior where the fall of water is considerable, and the supply limited. An endless chain, carrying a series of buckets, is made to revolve on two wheels, A B, called *rag-wheels*. The water flows into the highest bucket, and when it descends the next bucket takes its place and is likewise filled, and thus every bucket on one side is filled, while those on the opposite side, being inverted, are empty. The chain of buckets is therefore constantly carried round by the weight of the water.—*See fig.* 2.

Centrifugal Pump.—A machine dependent upon centrifugal force, combined with the pressure of the atmosphere. It consists of one, two, or more arms, erect below, and branching out above, joined to a vertical axle. Near the upper extremity of each arm is a clack valve opening upwards, while near the bottom of the vertical tube, or the bottom of each, (if there are more than one,) is a similar valve, also opening upwards. Water being poured into the machine before using, and a rapid motion being given to it by a handle at top, the water in the arms acquires a centrifugal force, opens the valves at the end, and flies out into a circular trough prepared for it. This machine is simple, but not so effective as a well-made pump.—*See fig.* 3.

Chain Pump.—An instrument which acts upon a principle contrary to that of the bucket engine: it may be either formed of buckets in the same manner, or what is more simple and common, instead of buckets, there are set at certain and regular intervals on an endless chain a series of pistons or round plates of metal, which nearly fit the calibre of the tubes in which they work. Putting the chain in motion, supposing the bottom of it to dip into the water of a well, each piston will inclose above it a certain quantity of water, and bear this water to the top, where it overflows into a cistern prepared to receive it.—*See fig.* 4.

Eccentric Pump.—Consists of a hollow drum or cylinder of metal, D D; in the interior of which, a solid cylinder, B, of the same length, but of less diameter, is made to revolve in water-tight axes. The inner cylinder being placed so much out of the centre of D D, that in its revolution, one side of it touches the side of B. The surface of the inner cylinder is also furnished with four circular flaps, C C C C. Two rods of metal slide through B, so as to open the valves on one side, when the opposite valves close by pressing against the case of D D. The water is supplied from the well, through A; it is then scooped up by the opening valve, and conveyed by that valve to the top, where, as the valve closes, the water is squeezed up into the pipe E.



THE LAW OF PATENTS.

We have been so often urged to give a paper or two on the patent laws, and believe it to be a subject so fraught with interest to all belonging to an inventive and manufacturing country like this, that it is with the very greatest pleasure we introduce a subject so generally interesting.

Patent, in law, is the exclusive right of using and vending a certain composition or combination of matter, as a medicine or a machine. This right is not derived from the law of nature, as the whole field of inventions and improvements is open to all men, and one cannot monopolize a part of it by prior discoveries. By the common law of England, monopolies were declared to be generally void, and patents for new inventions, being a species of monopolies, would, according to this doctrine, be void by that law. But they seem to form an exception to this rule; for it was held that the king could confer on the inventor of any useful manufacture or art the power of using it for a reasonable time. But the law of patents, as it now stands in England, rests upon a statute of 21 Jas. I, c. iii, and in the United States of America, on statute Feb. 21, 1793, and April 17, 1800. In France, until 1790, inventors were generally obliged to keep their discoveries secret, in order to secure to themselves a small part of the benefit of them. In an early period of the French revolution, a law was passed in favor of new inventions, formed on the basis of the English statute. The French law of Jan. 7, 1810, declares that every discovery or new invention, in every species of useful industry, is the property of its author. In England, patents are now, as they were before the statute of James I, granted by the crown. Letters patent are made out by the secretary of state in the name of the United States of America, bearing *teste* of the president.

What is patentable?—In general, any invention of a new and useful art, machine, manufacture, or composition of matter not known or used before, or any new and useful improvement in any art, machine, or manufacture, or composition of matter. The invention must be *new*. In England, a manufacture newly brought into the kingdom, from beyond sea, though not new there, is allowed by the statute of James; because that statute allows a patent for any new manufacture within this realm. By the patent law of the United States of America, if the thing patented was not originally discovered by the patentee, but had been in use, or had been described in some public work anterior to the supposed discovery by the patentee, or if he has surreptitiously obtained a patent for the discovery of another person, the patent is void. In France, by the law of Jan. 7, 1810, whoever introduces into that kingdom a foreign discovery shall enjoy the same advantages as if he were the inventor. In England, the publisher of an invention is entitled to a patent, whether he be the inventor or not. The subject of a patent must be vendible, in contradistinction to any thing that is learned by practice. The invention must be *material* and *useful*: thus the substitution of one material for another is insufficient to support a patent; as of brass hoops to a barrel instead of wooden ones. So there cannot be a patent for making in one piece what before was made in two. But if one elementary thing be substituted for another, as if that be done by a tube which was before done by a ring, a patent for the improvement would be good. It must not be hurtful to trade, nor generally inconvenient, nor mischievous, nor immoral, as an invention to poison people, or to promote debauchery. Patents for improvements are valid, as for an improved steam-engine; but if the improvements cannot be used without the engine which is protected by a patent, they must wait the expiration of the patent. But a new patent may be taken out for the improvement by itself. A combination of old materials, by which a new effect is produced, may be the subject of a patent. The effect may consist either in the production of a new article, or in making an old one in a better manner, in a shorter time, or at a cheaper rate. A patent may be obtained for a method or process by which something new or beneficial is done, when it is connected with corporeal substances, and is carried into effect by tangible means, as in the case of Watt's steam-engine, which was described to be a method of lessening the consumption of fuel in a steam-engine. So a chemical discovery, when it gives to the community some new, vendible, and beneficial substance, or compound article, is a subject of a patent, as medicines, &c. But a patent for a mere curiosity is void. If the manufacture in its new state merely answers as well as before, the alteration is not the subject of a patent; nor is a mere philosophical abstract principle, nor the application or practice of a principle, the subject of a patent. No patent can be obtained for the expansive operation of steam; but only for a new mode or application of machinery in employing it.

Right how lost.—The inventor may lose his right to a patent by using, or allowing others to use, his invention publicly. It was considered that Dr. Hall had not lost the right to a patent for his discovery of certain object-glasses, because he had not made it known to others, though it was not immediately patented. If the secret of an invention is known only to a few persons, and one of them puts it in practice, then a patent afterwards obtained by any one of them is void. This happened to Mr. Tennant, because a bleacher, who had not divulged the secret to any other person but his two servants, had used the same kind of bleaching-liquor for several years anterior to the date of Tennant's patent. Where a person who sought a patent for making spectacles incautiously told an acquaintance of the principle of the invention, by which means a person of the same trade made a similar pair, and the inventor, seeing them in a shop window, employed a friend to purchase them for him, and the patent was afterwards granted, it was said to be secure. The question does not, however, appear to have been brought before a court, and Mr. Godson thinks that the patent was void. A patent for British imperial verdigris was declared to be void, because the inventor had, four months prior to the sealing of the grant, sold the article under a different name. Whether experiments made with a view to try the efficacy of an invention, or the extent of a discovery, are a *using*, and dedicating the invention to the public, within the statute of James, has not been decided; but it would be difficult to say how much a substance or machine might be used without running great risk of invalidating the right to a patent. In France, if the inventor do not, within two years, put his discovery into activity, or do not justify his inaction, the patent is annulled.

Duration of the Patent.—In England and the United States of America, patents are granted for a term not exceeding fourteen years. The time in England may be prolonged by a private act, and, in the United States of America, by act of congress. In France, by the law already mentioned, patents are given for five, ten, or fifteen years, at the option of the inventor; but this last term is never to be prolonged without a particular decree of the legislature. The duration for imported discoveries is not to extend beyond the term fixed for the privilege of the original inventor in his own country.—In France, if the inventor obtains a patent in a foreign country, after having obtained one in France, the patent is annulled.—*Caveat.* In England, a *caveat* is an instrument by which notice is requested to be given to the person who enters it, whenever any application is made for a patent for a certain invention, which is therein described in general terms. It must be renewed annually. It is simply a request that, if any other person should apply for a patent for the same thing, the preference may be given to him who entered it. In the United States of America, in case of interfering applications for a patent, they are submitted to the arbitration of three persons, appointed one by each applicant, and one by the secretary of state.

Specification.—The invention for which a patent is granted must be accurately ascertained and particularly described. The disclosure of the secret is the price of the monopoly. The specification must be such that mechanics may be able to make the machine by following the directions of the specification, without any new inventions of their own. The patent and specification are linked together by the title given to the invention in the patent, and the description of it in the specification. The specification must support the title of the patent; thus a patent taken out for *tapering-brush* is not supported by the specification of a brush in which the bristles are of unequal lengths. It must point out what parts are new and what old. It must not cover too much; if it does so, it is not effectual, even to the extent to which the patentee would be otherwise entitled; as, if there be a patent for a machine and for an improvement upon it, which cannot be sustained for the machine, although the improvement is new and useful, yet the grant altogether is invalid, on account of its attempting to cover too much. A patent for a new method of drying and preparing malt is not sustained by a specification in which is described a method for heating, &c., ready-made malt: so a patent for an invention founded on a principle already known, for lifting fuel into the fire grate from below the grate, in the specification whereof was described a new apparatus, was held to be bad for not claiming the new instrument as the thing invented: so when a patent was "for a new method of completely lighting cities, towns, and villages," and the specification described improvements upon lamps, the patent was held to be void. The subject must be given to the public in the most improved state known to the inventor. A patent, in England, for steel trusses was held to be void, because the inventor omitted to mention that, in tempering the steel, he rubbed it with tallow, which was of some use in the operation. The specification must not contain a description of more than the improvement or addition. If there be several things specified that may be produced and one of them is not new, the whole patent is void. In England, if any considerable part of a manufacture be unnecessary to produce the desired effect, it will be presumed that it was inserted with a view to perplex and embarass the inquirer: thus, in 1 Term Reports, 602, in Turner's patent for producing a yellow color, among other things, *minium* is directed to be used, which, it appeared, would not produce the desired effect, and, for this reason, the validity of the patent might be impeached. In the specification of Winter's patent, 1 Term Reports, 602, a great number of salts were mentioned, by which it appeared that either might be used to make the subject of the patent, but only one would, in fact, produce the effect; and, for this reason, the patent was held to be void. If the patentee makes the article of cheaper materials than those which he has enumerated in his specification, although the latter answer equally as well, the patent is void.—In England, if the improved manner of using the invention be unintentionally left undescribed, still the patent is void. (1 *Mason's Reports*, 189.) In France, the general rules, in these respects, are similar.

(To be continued.)

OF ECLIPSES.

(Resumed from page 76.)

Of all the various phenomena of the heavens, there are none which have created so much curiosity, excited so much interest, or caused so much surprise throughout the world, as eclipses of the sun and moon; and to those who are unacquainted with the principle of astronomy, there is nothing, perhaps, which appear more extraordinary than the accuracy with which they can be predicted.

In the earlier ages of the world, before science had enlightened the minds of men, appearances of this kind were generally regarded as alarming deviations from the established laws of nature; and but few, even among philosophers themselves, were able to account for these extraordinary appearances.—At length, when men began to apply themselves to observations, and when the motions of the celestial bodies were better understood, these phenomena were not only found to depend upon a regular cause, but to admit of a natural and easy solution. There are, however, nations that still entertain the most superstitious notions[*] respecting eclipses, particularly the Mexicans and Chinese.

Thus, when the infant moon her circling sphere
Wheels o'er the sun's broad disk, her shadow falls
On earth's fair bosom; darkness chills the fields,
And dreary night invests the face of heaven.
Reflected from the lake full many a star
Glimmers with feeble languour. India's sons
Affrighted in wild tumult rend the air.
Before his idol god with barb'rous shriek
The Brachman[*] falls, when soon the eye of day
Darts his all-cheering radiance, from the gloom
Emerging Joy invades the wond'ring crowd,
And acclamation rushes from the tongues
Of thousands, that around their blazing pile
Riot in antic dance and dissonant song.—Zouch.

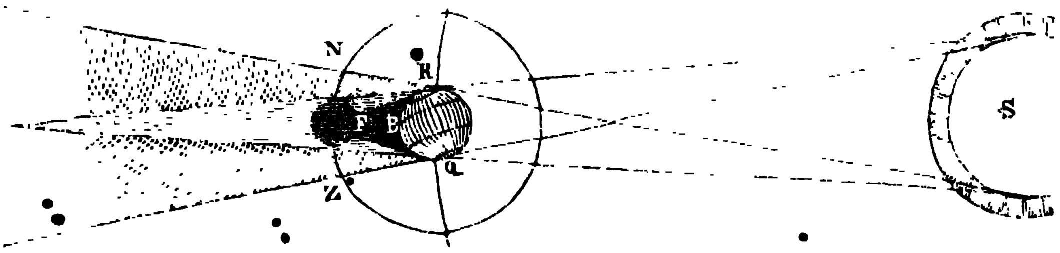
Many instances are to be found, not only in ancient, but even in comparatively modern history, where the superstition of the times has continued to connect the records of eclipses with the details of some remarkable event, which either happens soon after or during their continuance. But these details being foreign to the nature of the present paper, we shall proceed to give an account of the causes, and various kinds of eclipses of the sun and moon.

As every planet, belonging to the solar system, both primary and secondary, derives its light from the sun, it must cast a shadow towards that part of the heavens which is opposite to the sun. This shadow is, of course, nothing but a privation of light in the space hid from the sun by the opaque body, and will always be proportionate to the relative magnitudes of the sun and planet. If the sun and planet were both of the same size, the form of the shadow cast by the planet would be that of a cylinder, the diameter of which would be the same as that of the sun or planet, and it would never converge to a point. If the planet were larger than the sun, the shadow would continue to spread or diverge; but as the sun is much larger than the greatest of the planets, the shadows cast by any one of these bodies must converge to a point, the distance of which from the planet will be proportionate to the size and distance of the planet from the sun. The magnitude of the sun is such that the shadow cast by each of the primary planets always converges to a point before it reaches any other planet; so that not one of the primary planets can eclipse another, yet the shadow

[*] Although the Chinese perform the most ridiculous and superstitious ceremonies during the time of an eclipse, yet they can calculate them with the greatest precision.

of any planet which is accompanied by satellites, may, on certain occasions, eclipse these satellites; but it is not long enough to eclipse any other body. The shadow of a satellite or moon may also, on certain occasions, fall on the primary and eclipse it.

Eclipses of the sun and moon happen when the moon is near her nodes, that is, when she is either in the plane of the ecliptic or very near it. Those of the sun happen only at new moon, or when the moon is in conjunction with the sun; whilst those of the moon happen at the time of *full moon*, or when the moon is in opposition to the sun. The sun, earth, and moon, must, therefore, always be nearly in the same straight line at the time of an eclipse; and conversely, when these three bodies are nearly in a straight line, an eclipse must take place. Hence it is evident, that an eclipse happens in consequence of one of the two opaque bodies, the earth and the moon, being so placed as to prevent the sun's light from falling on the other. See the following figure, which represents the moon passing through the dark shadow of the earth, as she moves in her orbit N Z, while the earth moves in the ecliptic R Q.



The interposition of the moon between the sun and the earth produces an eclipse of the sun; and the interposition of the earth between the moon and the sun, so that its shadow falls on the moon, produces an eclipse of the moon. On these principles the whole phenomena of eclipses depend, and admit of complete explanation.

If the moon's orbit were coincident with the plane of the ecliptic, the moon's shadow would fall upon the earth, and occasion a *central eclipse* of the sun at every conjunction, or new moon; whilst the earth's shadow would fall on the moon, and occasion a total eclipse of that body at every opposition or full moon. For as the moon would then always move in the ecliptic, the centres of the sun, earth, and moon, would all be in the same straight line at both of these times. But the moon's orbit is inclined to the ecliptic, and forms with it an angle of about 5° 10′; and, therefore, the moon is never in the ecliptic except when she is in one of her *nodes*: hence, there may be a considerable number of conjunctions and oppositions of the sun and moon without any eclipse taken place.

The moon is always at some distance from the ecliptic, except when she is in one of her *nodes*;—and this distance is called her *latitude*, which is north or south, according as the moon is on the north or south side of the ecliptic. Now if the moon has any latitude, there cannot be a *central* eclipse, for this can only happen when the moon is in one of her nodes at the moment of conjunction, which is very seldom the case; and, of course, very few central eclipses of the sun have taken place since the creation of the world. But the section of the earth's shadow (through which the moon passes when she is eclipsed) being much larger than the disc of the moon, the moon may be *totally* eclipsed, although she be at some distance from her node at the time of opposition; but its duration will be the greater the nearer she is to the node. An eclipse of the *sun* may also happen, although the moon be at some distance from her node at the time of conjunction; but its form, as well as its duration, depends very much upon that distance. This circumstance has occasioned the division of eclipses into central, total, annular, and partial.

As the meaning of these terms must be obvious to the reader, it is almost unnecessary to give an explanation of them.

A central eclipse, is that in which the centre of the shadow falls on the centre of the body which is eclipsed.

A total eclipse is the obscuration of the whole body eclipsed.

An annular eclipse is that in which the whole of the body eclipsed is hid, except a ring round its edge, which remains luminous.

A partial eclipse is that in which part of the body is hid from view.

(To be continued.)

ESSENTIAL OR VOLATILE OILS.

(Resumed from page 104.)

Oil of Bitter Almonds, is prepared by exposing the bitter almond cake, from which the bland oil has been expressed, in a sieve to the vapor of water rising within the still. The steam, as it passes up through the bruised almond *parenchyma*, carries off its volatile oil, and condenses along with it in the worm. The oil which first comes over, and which falls to the bottom of the water, has so pungent and penetrating a smell, that it is more like cyanogen gas than hydrocyanic or prussic acid. This oil has a golden-yellow color, it is heavier than water; when much diluted, it has an agreeable smell, and a bitter burning taste. When exposed to the air, it absorbs oxygen, and lets fall a heap of crystals of benzoic acid. This oil consists of a mixture of two oils; one of which is volatile, contains hydrocyanic acid, and is poisonous; the other is less volatile, is not poisonous, absorbs oxygen, and becomes benzoic acid. If we dissolve 100 parts of the oil of bitter almonds in spirit of wine, mix with the solution an alcoholic solution of potash, and then precipitate the oil with water, we shall obtain a quantity of cyanide of potash, capable of producing 22½ parts of Prussian blue. Oil of bitter almonds combines with the alkalis. Perfumers employ a great quantity of this oil in scenting their soaps. One manufacturer in Paris is said to prepare annually 3 cwt. of this oil. A similar poisonous oil is obtained by distilling the following substances with water:—The leaves of the peach, (*amygdalus* *persica,*) the leaves of the bay-laurel, (*prunus lauro-cerasus,*) the bark of the plum tree, (*prunus padus,*) and the bruised kernels of cherry and plum-stones. All these oils contain hydrocyanic acid, which renders them poisonous, and they also generate benzoic acid, by absorbing oxygen on exposure to air.

Oil of Anise-seed, is extracted by distillation from the seeds of the *pimpinella anisum.* It is either colorless, or has merely a faint yellow color, with the smell and taste of the seed. It concretes in lamellar crystals at the temperature of 50°, and does not melt again till heated to 64° nearly. Its specific gravity at 61° is 0·9958, and at 77°, 0·9857. It is soluble in all proportions in alcohol of 0·806; but only to the extent of 42 per cent. in alcohol of 0·84. When it becomes resinous by long exposure to the air, it loses its congealing property. It consists of two oils; a solid stearessence, and a liquid oleiessence, which may be separated by compression of the cold concrete oil.

Oil of Bergamot, is extracted by pressure from the rind of the ripe fruit of the *citrus bergamium* and *aurantium.* It is a limpid, yellowish fluid, having a smell resembling that of oranges. Its specific gravity varies from 0·888 to 0·885. It becomes concrete when cooled a little below 32°.

Oil of Cajeput, is prepared in the Moluccas, by distilling the dry leaves of the *melaleuca leucadendron.* Cajeput is a native word, signifying merely a white tree. This oil is green; it has a burning taste, a strong smell of camphor, turpentine, and savine. It is very fluid, and at 48° has a specific gravity of 0·948. The color seems to be derived from the copper vessels in which it is imported, so that it is removed by distillation with water, which also separates the oil into two sorts; the first which comes over having a density of 0·897, the last of 0·920. This has a green color.

The Oil of Caraway, is extracted from the seeds of the *carum carui.* It has a pale yellow color, and the smell and taste of the plant. Its specific gravity is 0·960. The seeds of the *cuminum cyminum,* (cumin,) afford an oil similar to the preceding, but not so agreeable. Its specific gravity is 0·975.

The Oil of Cassia, from the *laurus cassia,* is yellow passing into brown, has a specific gravity of 1·071, and affords a crystalline stearessence by keeping in a somewhat open vessel.

The Oil of Chamomile, is extracted by distillation from the flowers of the *matricaria chamomilla.* It has a deep blue color, is almost opaque, and thick; and possesses the peculiar smell of the plant. In the atmosphere it becomes brown and unctuous. If an ounce of oil of lemons be added to 3 lbs. of this oil, they make it separate more readily from the adhering water.

Other blue oils, having much analogy with oil of chamomile, are obtained by distilling the following plants:—Roman chamomile, (*anthemis nobilis,*) the flowers of *arnica montana,* and those of milfoil, (*achillæa millefolia.*) The last has a specific gravity of 0·852.

Oil of Cinnamon, is extracted by distillation from the bark of the *laurus cinnamomum.* It is produced chiefly in Ceylon, from the pieces of bark unfit for exportation. It is distilled over with difficulty, and the process is promoted by the addition of salt water, and the use of a low still. It has at first a pale yellow color, but it becomes brown with age. It possesses in a high degree both the sweet burning taste, and the agreeable smell of cinnamon. It is heavier than water; its specific gravity being 1·035. It concretes below 32° F., and does not fuse again till heated to 41°. It is very sparingly soluble in water, and when agitated with it readily separates by repose. It dissolves abundantly in alcohol, and combines with ammonia into a viscid mass, not decomposed on exposure to air.

When oil of cinnamon is kept for a long time, it deposits a stearessence in large regular colorless or yellow crystals, which may be pulverized, and which melt at a very gentle heat into a colorless liquid, which crystallises on cooling. It has an odour intermediate between that of cinnamon and vanilla; and a taste at first greasy, but afterwards burning and aromatic. It crackles between the teeth. It requires a high temperature for distillation, and becomes then brown and empyreumatic. It is very soluble in alcohol.

The Oil of Cloves, is extracted from the dried flower buds of the *caryophyllus aromaticus.* It is colorless, or yellowish, has a strong smell of the cloves, and a burning taste; its specific gravity is 1·061. It is one of the least volatile oils, and the most difficult to distil. At the end of a certain time it deposits a crystalline concrete oil. A similar *stearessence* is obtained by boiling the bruised cloves in alcohol, and letting the solution cool. The crystals thus formed are brilliant, white, grouped in globules, without taste and smell. Oil of cloves has remarkable chemical properties. It dissolves in alcohol, ether, and acetic acid. It does not solidify at a temperature of 4° under 0° F., even when exposed to that cold for several hours. It absorbs chlorine gas, becomes green, then brown, and turns resinous. Nitric acid makes it red, and if heated upon it, converts it into oxalic acid. If mixed by slow degrees with one-third of its weight of sulphuric acid, an acid liquor is formed, at whose bottom a resin of a fine purple color is found. After being washed, this resin becomes hard and brittle. Alcohol dissolves it, and takes a red color; and water precipitates it of a blood-red hue. It dissolves also in ether. When we agitate a mixture of strong caustic soda lye and oil of cloves in equal parts, the mass thickens very soon, and forms delicate lamellar crystals. If we then pour water upon it, and distil, there passes along with the water, a small quantity of an oil which differs from oil of cloves both in taste and chemical properties. During the cooling, the liquor left in the retort lets fall a quantity of crystalline needles, which being separated by expression from the alkaline liquid, are almost inodorous, but possess an alkaline taste, joined to the burning taste of the oil. These crystals require for solution from 10 to 12 parts of cold water. Potash lye produces similar effects. Ammoniacal gas transmitted through the oil is absorbed and makes it thick. The concrete combination thus formed remains solid as long as the phial containing it is corked, but when opened, the compound becomes liquid; and these phenomena may be reproduced as many times as we please. Such combinations are decomposed by acids, and the oil set at liberty has the same taste and smell as at first, but it has a deep red color. The alkalis enable us to detect the presence of other oils, as that of turpentine or sassafras, in that of cloves, because they fix the latter, while the former may be volatilized with water by distilling the mixture. The oil of cloves found in commerce is not pure, but contains a mixture of the tincture of pinks or clove-gilly flowers, whose acrid resin is thereby introduced. It is sometimes sophisticated with other oils.

The Oil of Elder, is extracted by distillation from the flowers of the *sambucus nigra.* It has the consistence of butter.

Oil of Fennel, is extracted by distillation from the seeds of the *anethum fœniculum.* It is either colorless or of a yellow tint, has the smell of the plant, and a specific gravity of 0·997. When treated with nitric acid, it affords benzoin. It congeals at the temperature of 14° F., and then yields by pressure a solid and a liquid oil; the former appearing in crystalline plates. It is used in this country for scenting soap.

Oils of Fermented Liquors.—The substances usually fermented contain a small quantity of essential oils, which become volatile along with the alcoholic vapors in distillation, and progressively increase as the spirits become weaker towards the end of the process. The vapors then condense into a milky liquor. These oils adhere strongly to the alcohol, and give it a peculiar acrid taste. They differ according to the vinous wash from which they are obtained, and combine with greater or less facility with caustic alkalis.

1. *Oil of Grain Spirits.*—At the ordinary temperature it is partially a white solid; when cooled lower, it assumes the aspect of suet, and therefore consists chiefly of stearessence. Its taste and smell are most offensive; it swims upon the surface of water, and even of spirit containing 30 per cent. of alcohol. It sometimes derives a green color from the copper worm of the still. When heated it fuses and turns yellow. When it has become resinous by the agency of the atmosphere, it gives a greasy stain to paper. It dissolves in 6 parts of anhydrous alcohol, and in 2 of ether; and is said to crystallize when the spirit solution has been saturated with it hot, and is allowed to cool. By exposure to a freezing mixture, the whiskey which contains it lets it fall. Caustic potash dissolves it very slowly, and forms a soap soluble in 60 parts of water. It is absorbed by wood charcoal, and still better by bone black; whereby it may be completely abstracted from bad whiskey. According to Buchner, another oil may also be obtained from the residuum of the second distillation of whiskey, if saturated with sea salt, and again distilled. Thus we obtain a pale yellow fluid oil, which does not concrete with cold, possessed of a disagreeable smell and acrid taste. Its specific gravity is 0·835. It is soluble in alcohol and ether.

2. *The Oil from Potato Spirits*, has properties quite different from the preceding. It is obtained in considerable quantity by continuing the distillation after most of the alcohol has come over, and it appears in the form of a yellowish oil, mixed with water and spirits. After, being agitated first with water, then with a strong solution of muriate of lime, and distilled afresh, it possesses the following properties:—It is colorless, limpid, has a peculiar smell, and a bitter hot taste of considerable permanence. It leaves no greasy stain upon paper, remains liquid at 0° F., but cooled below that point it crystallises like oil of anise-seed. When pure it boils at 257° F.; but at a lower degree, if it contains alcohol. Its specific gravity is 0·821, or 0·823, when it contains a little water. It burns with a clear flame without smoke, but it easily goes out, if not burned with a wick. It dissolves in small quantity in water, to which it imparts its taste and the properties of forming a lather by agitation. It dissolves in all proportions in alcohol. Chlorine renders it green. Concentrated sulphuric acid converts it into a crimson solution, from which it is precipitated yellow by water. It dissolves in all proportions in acetic acid. Concentrated caustic lyes dissolve it, but give it up to water. It does not appear to be poisonous, like the oil of corn spirits; because, when given by spoonsful to dogs, it produced no other effect but vomiting.

3. *The Oil of Brandy, or Grape Spirits*, is obtained during the distillation of the fermented residuum of expressed grapes; being produced immediately after the spirituous liquor has passed over. It is very fluid, limpid, of a penetrating odour, and an acrid disagreeable taste. It grows soon yellow in the air. When this oil is distilled, the first portions of it pass unchanged, but afterwards it is decomposed and becomes empyreumatic. It dissolves in 1000 parts of water, and communicates to it its peculiar taste and smell. One drop of it is capable of giving a disagreeable flavor to ten old English gallons of spirits. It combines with the caustic alkalis, and dissolves sulphur.

Oil of Juniper, is obtained by distilling juniper berries along with water. These should be bruised, because their oil is contained in small sacs or reservoirs, which must be laid open before the oil can escape. It is limped and colorless, or sometimes of a faint greenish yellow color. Its specific gravity is 0·911. It has the smell and taste of the juniper. Water, or even alcohol, dissolves very little of it.—Gin contains a very minute quantity of this oil.—Like oil of turpentine, it imparts to the urine of persons who swallow it, the smell of violets. Oil of juniper is frequently sophisticated with oil of turpentine introduced into the still with the berries —a fraud easily detected by the diminished density of the mixture.

The Oil of Lavender, is extracted from the flowering spike of the *lavandula spica.* It is yellow, very fluid, has a strong odour of the lavender, and a burning taste. The specific gravity of the oil found in commerce is 0·898 at the temperature of 72° F., and of 0·877 when it has been rectified. It is soluble in all proportions in alcohol of 0·830, but alcohol of 0·887 dissolves only 42 per cent. of its weight. The fresh oil detonates slightly when mixed with iodine, with the production of a yellow cloud. There occurs in commerce a kind of oil of lavender known under the name of oil of *aspic* or oil of *spike*, extracted by distillation from a wild variety of the *lavandula spica*, which has large leaves, and is therefore called *latifolia.* This oil is manufactured in the south of Europe. Its odour is less characteristic than that of the lavender, resembling somewhat that of oil of turpentine, with which it is indeed often adulterated. It is also so cheap as to be sometimes used instead of the latter oil. Oil of lavender deposits, when partially exposed to the air, a concrete oil, which resembles camphor, to the amount of one-fourth of its weight.

The Oil of Nutmegs, is extracted chiefly from mace, which is in the inner epidermis of these nuts. It is colorless, or yellowish, a little viscid with a strong aromatic odour of nutmegs, an acrid taste, and a specific gravity of 0·948. It consists of two oils, which may be easily separated from each other by agitation with water; for one of them, which is more volatile and aromatic comes to the surface, while the other, which is denser, white, and of a buttery consistence, falls to the bottom.

(To be continued.)

MEDICAL RECEIPTS.

Buxton Water.—Imitated by dissolving in a bottle of filtered water, 15 grains of carbonate of soda, half a dram of tartrate of soda, with 80 minims of wine of iron: before corking add 8 minims of sulphuric acid.

Campbell's Green Liniment.—Made with 1 ounce each of camphor and of extract of hemlock, 2 ounces of compound spirit of ammonia, 6 ounces each of liquor ammoniæ and of olive oil. For swellings and enlarged joints.

Camphor Balls, such as Selway's, in perfumery, are made by grinding in a starch-mill 6 pounds of very dry starch, 3 pounds of very dry white lead, sifting it through a lawn sieve, and then mixing it with 14 pounds of very fine rice powder. Then shave down and dry 48 pounds of the best oil soap, and mix with the former. Next grind 1½ pound of camphor in an iron mortar, with half a pint of Hungary water, and add gradually half an ounce each of oil of rosemary and of lavender. When reduced to powder, add a few pounds of the prepared soap, and after beating it well mix the whole together, and make it in the same way as ambergris wash-balls. Used as a cosmetic, but not safely.

Camp Vinegar, is made by steeping in the best vinegar for a month 1 dram of cayenne pepper, 2 table-spoonsful of soy, and 4 of walnut-ketchup, 6 anchovies, chopped, and a small clove of garlic, minced fine. Shake it frequently, strain through a tammis, and keep it well corked in small bottles.

Catholicon Duplicatum Rheo. P.—The double catholicon of nicolai, or compound electuary of rhubarb, is prepared by simmering over a slow fire half a pound of polypody root, 2 ounces of succory root, 1 ounce of liquorice root, 3 ounces of the leaves of agrimony and spleenwort, 6 pounds of water, till reduced two-thirds; add 6 drams of fennel-seeds, strain and add 4 pounds of sugar, boil to the consistence of syrup, and add 4 ounces each of extract of cassia and pulp of tamarinds. Then add by degrees 4 ounces each of powdered rhubarb and senna leaves, 1 ounce of liquorice root, 2 ounces of seeds of violet, 1 ounce of the four cold seeds, half an ounce of fennel-seeds, and mix and form an electuary. It is too troublesome in the preparation to be much used. Without the rhubarb, and with honey instead of sugar, it forms a good enema. It was formerly esteemed a universal remedy, but is now disused.

Chamberlain's Restorative Pills.—Dr. Paris discovered by analysis that these pills consist of cinnabar, sulphur, sulphate of lime, and a little vegetable matter. The inventor, who resides at Ipswich, says the pills are the most certain cure for scrofula, fistula, scurvy, and all impurities of the blood, but often take two years to effect a cure.

Chamomile Drops.—This nostrum is nothing more than spirits to which a little of the oil of chamomile has been added, for the sake of the odour and taste; but possesses none of the medicinal qualities of the flowers.

Chelsea Pensioner.—A well-known gout nostrum, said to have been invented by a Chelsea pensioner, and is prepared by making an electuary of 1 dram of guaiac, 2 drams of rhubarb, in powder, 1 ounce of nitrate of potass, and 1 ounce of flowers of sulphur, with 1 nutmeg, in powder. Dose two table-spoonsful, night and morning, as a purgative and diaphoretic.

Ching's Worm Lozenges.—A popular nostrum for worms, consisting of two preparations, the basis of both of which is chloride of mercury.

The Yellow Lozenges, are prepared by mixing 1 pound of chloride of mercury, washed in alcohol, with 4 drams of saffron that has been boiled in 1 pint of water, and strained, and 28 pounds of white sugar, making the whole into a mass with gum tragacanth mucilage, and rolling it out to an exact thickness. Each lozenge should contain 1 grain of the chloride. The dose is one lozenge at bed-time, and on the succeeding morning a brown lozenge is to be taken.

The Brown Lozenges.—Take 7 ounces of the chloride of mercury, washed as before, 3½ pounds of jalap, 9 pounds of white sugar, and enough of gum tragacanth mucilage to make a mass. Each lozenge should contain half a grain of the chloride.

These nostrums are by no means safe, as the chloride is seldom diffused equally, and may in some lozenges be in dangerous quantity. When long kept, also, or exposed to damp, they may acquire poisonous properties.

Cochrane's Cough Medicine.—A nostrum which bears the name of Major Cochrane, is prepared by making a decoction of the heads of white poppies previously freed from the seeds; strain this, boil it again with vinegar and brown sugar to the consistence of syrup; then add sulphuric acid till it is pretty sour.

Corn Plaster.—The common green corn plaster is prepared by melting 4 parts of Burgundy pitch, with 3 parts of wax, 2 parts of turpentine, and 1 part of diacetate of copper or Ærugo, and spreading the whole on cloth to a proper thickness; or mix and spread 3 parts of mercurial ammoniacal plaster, and 1 part of resin opiate plaster. *Corn Solution*, is solution of potass.

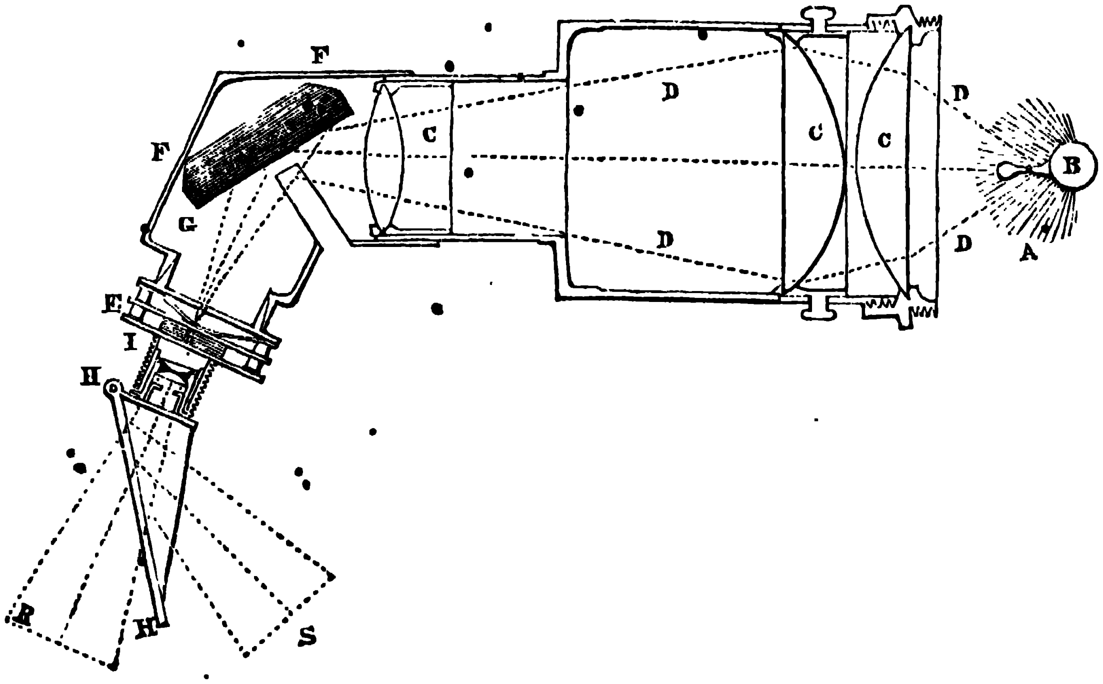
Court Plaster, or Black Sticking Plaster.—Take half an ounce of benzoin, and 6 ounces of rectified spirit, dissolve and strain; then take 1 ounce of isinglass, and half a pint of hot water, dissolve and strain separately from the former. Mix the two, and set them aside to cool, when a jelly will be formed; and this is warmed and brushed ten or twelve times over a piece of black silk, stretched smooth. When this is done enough, and dry, finish it with a solution of 4 ounces of Chian turpentine, in 6 ounces of tincture of benzoin.

Daffy's Elixir, (*Dicey's.*)—Take 4 ounces of senna leaves, 2 ounces each of rasped guaiac wood, dried elecampane root, coriander-seeds, anise-seeds, caraway-seeds, and liquorice root, 8 ounces of stoned raisins, 6 pints of proof spirit. Digest for a week, strain through bibulous paper, and add half a pound of treacle. Sometimes given to horses.

Swinton's Daffy's Elixir.—Take 3 pounds of jalap root, 12 ounces of senna leaves, 4 ounces each of coriander-seed, anise-seed, liquorice root, and elecampane root, 1 gallon each of wine and water. Digest for three weeks, strain, and add a gallon of treacle. Dose 2 drams to 6 drams as a carminative.

Damask Powder, in perfumery, is prepared by beating well in a mortar 3 pounds of cypress powder and dry damask roses. Sift the powder through a fine cypress sieve, beating it and returning it till it is sufficiently fine. The roses make it light and soft.

Fig. 1.



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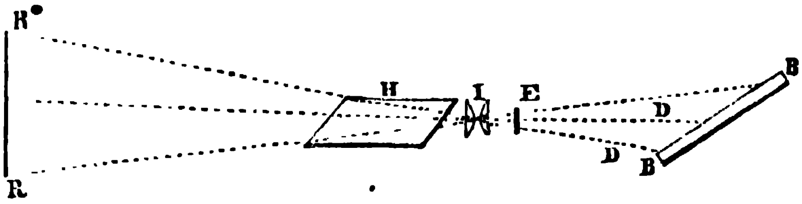
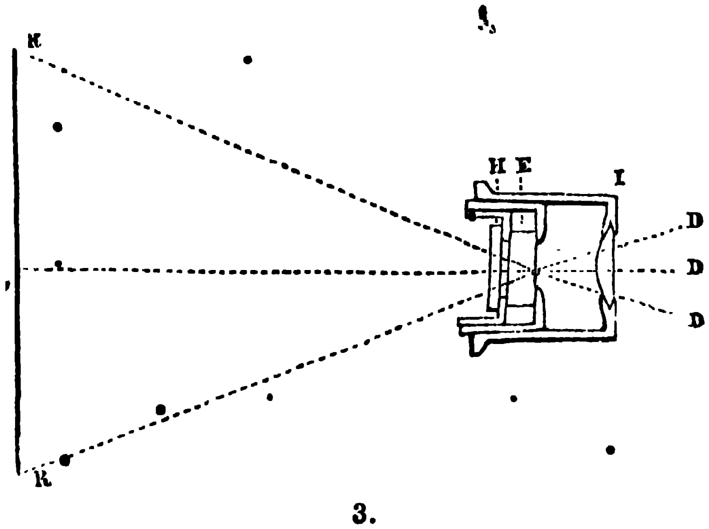


GODDARD'S OXY-HYDROGEN POLARISCOPE.



3.

THE OXY-HYDROGEN POLARISCOPE.

(Resumed from page 102, and concluded.)

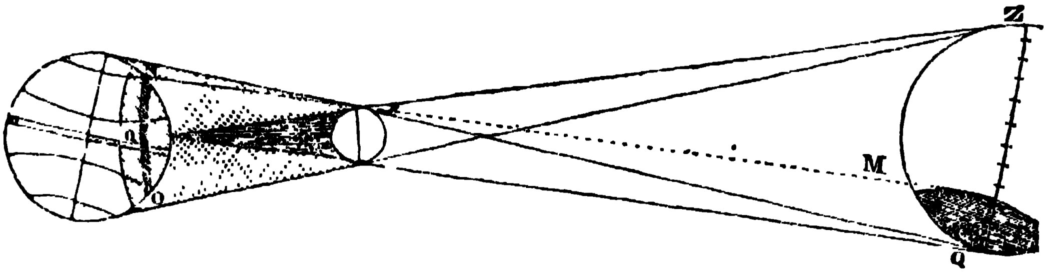
It has been already stated that the object of the preceding papers on the polarization of light has been to introduce and illustrate the polariscope of Mr. Goddard, of which the following is a plain description; merely premising that the nozzle of the instrument, or that which is thus described, is to be fitted on the front of a magic lanthorn, oxy-hydrogen microscope, &c.

Fig. 1. A, the compound jet of the hydro-oxygen blowpipe; B, a pallet of lime ignited by the flame of a jet of hydrogen and oxygen gases impinging upon it; D, diverging rays of light refracted by the condensing lenses C C C, and falling upon a mirror F F, composed of ten plates of thin flatted crown glass, placed in the elbow of a tube bent to the polarizing angle of crown glass, C, conveying rays of polarized light reflected from the mirror; H H, a bundle of sixteen plates of mica for analysing the light previously polarized by reflection; E, a double reflecting crystal (film of selenite) placed in the focus of the object-glass I, which forms an image of the crystal upon a disc or screen at R. As the analysing bundle of mica H H, is made to revolve (or turn round), the image of the selenite upon the disc undergoes all the changes, and exhibits alternately the primary and complementary colors. This apparatus has the advantage of exhibiting both the primary and complementary colors at the same time, one being reflected in the direction S, and the other transmitted and seen at R.

The great advantage of polarizing the light by reflection from a number of plates, is the obtaining a beam of any required dimensions, of much greater intensity than by any other means; for, whatever single surface may be employed that polarizes the light at the same angle as the glass used (which, for crown glass, is 56° 45′), we obtain an additional quantity by laying on it a single plate of such glass, and a further quantity by the addition of a second, third, or any further number; the quantity of light added by each succeeding plate being, however, less in proportion to the number of plates through which it has previously to pass.

In this respect, the single image (Nicol's) prism of Iceland spar is decidedly the best for analysing, as by this a great variety of objects may be exhibited. Its application is shown in fig. 2, where E is the selenite placed in the rays D D D of polarized light, an image of which is projected by the lenses I. H is the analysing prism through which the rays of light R R are refracted.

But there is one class of phenomena, viz. the rings seen to encircle the optic axes of crystals, the number of which increase in some crystals (the topaz, for example), with the divergence of the rays of polarized light passing through them. It will be evident, then, that the tourmalines enable us to exhibit more of these rings, and upon a larger scale than the prism, which will be better understood by the arrangement shewn in fig. 3. D D D, converging rays of light polarizing by reflection; I, a lens of short focus transmitting a cone of light with an angle of divergence for its rays R R, of 45°. E, a crystal, say topaz; H, the tourmaline for analysing; so that, even for these purposes, the cost of the tourmalines is reduced one half by the polariscope, as only one need be used.



OF ECLIPSES.

(Resumed from page 109.)

The above figure represents a partial eclipse of the sun, which will be visible to that tract of the earth marked N Q O, the line M N marks the greatest obscuration.

If the distance be very small, the eclipse will be the greater, and continue the longer; but no eclipse of the sun can be either *central* or total, except the moon be in the very node at the time of conjunction. But should she be in this situation when she is at her least distance from the earth, and the earth, at the same time, at its least distance from the sun, then the eclipse will not only be central but *total*, and continue so for a few minutes. But if the moon happens to be at her greatest distance from the earth, and the earth at its greatest distance from the sun, the eclipse will be annular, or a small space round the sun's centre only will be hid from view, and a bright lucid ring round his edge will remain visible.

If the moon be less than 17⅛ degrees from either node at the time of conjunction, her shadow will fall more or less upon the earth, according as she is more or less within this limit; and, of course, the sun will suffer a partial eclipse. And if she be less than 12½ degrees from either node at the time of opposition, she will pass through more or less of the earth's shadow, according as she is more or less within these lines, and, of course, she will suffer an eclipse.

As these limits form but a small part of the moon's orbit, which is 360 degrees, eclipses happen but seldom; however, in no year can there be fewer than two, and there may be seven of the sun and moon together—but taking one year with another, there are about four each year. But as the sun and moon spend as much time below the horizon of any place as above it, half the number of the eclipses will be *invisible* at any particular place, and consequently, there will be only *two* eclipses visible in a year at that place, the one of the sun and the other of the moon.*

Every eclipse, whether of the sun or moon, is *visible* at some place of the earth's surface, and invisible at others; for the rational horizon of every place divides both the earth and heavens into two equal portions or hemispheres; and as no celestial body can be seen except it be above the spectator's horizon, it follows that any eclipse which is visible in the one hemisphere cannot be visible in the other, because the body which is eclipsed is below the horizon of that other. If a lunar eclipse, for example, happens at any hour of night, between the time of sun-setting and sun-rising, at any particular place, it will be visible there, and invisible to the inhabitants of the opposite hemisphere, who have the sun above their horizon at that time; for the sun and moon are in opposite parts of the heavens at the time of a lunar eclipse. And with respect to solar eclipses, it is evident that they can only be seen at any place when the sun is above the horizon of that place. There is, however, a difference with regard to the visibility of solar and lunar eclipses;—for an eclipse of the moon has the same appearance to all the inhabitants of that hemisphere to which the moon is visible at the time, owing, in part, to the small distance of the moon from the earth.—But an eclipse of the sun may be visible to some places and invisible to others in the same hemisphere of the earth, because the moon's shadow is small in comparison of the earth; for its breadth, excluding the penumbra, is only about 180 miles even in central eclipses.* Hence those places which are considerably distant from the path of the shadow will either have no eclipse at all, or a very small one; while places near the middle of the shadow will have the greatest possible. There is also a difference in the absolute time at which a solar eclipse happens at the various places it is visible; for it appears more early to the western parts, and later to the eastern, on account of the motion of the moon (and, of course, her shadow) from west to east.

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* If there be seven eclipses in any year, five of them must be of the sun and two of the moon.

In most solar eclipses the moon's disc may be observed by a telescope to be covered by a faint light, which is attributed to the reflexion of light from the illuminated part of the earth. When the eclipses are total, the moon's limb is surrounded by a pale circle of light, which some astronomers consider as an indication of a lunar atmosphere, but others, as occasioned by the atmosphere of the sun, because it has been observed to move equally with the sun and not with the moon.

Dr. Halley, in describing a central eclipse of the sun, which happened at London, in April, 1715, says, that although the disc of the sun was wholly covered by the moon, a luminous ring of a faint pearly light surrounded the body of the moon the whole of the time; and its breadth was nearly a tenth of the moon's diameter.

In lunar eclipses, the moon seldom disappears entirely; and, on some occasions, even the spots may be distinguished through the shade; but this can only be the case when the moon is at her greatest distance from the earth at the time of the eclipse, for the nearer the moon is to the earth the darkness is the greater. In some instances, the moon has disappeared entirely; and the celebrated astronomer, Heraclius, has taken notice of one where the moon could not be seen even with a telescope, though the night was remarkably clear.

Although eclipses of the sun and moon were long considered, by the ignorant and superstitious, as presages of *evil*, yet they are of the greatest use in astronomy, and may be employed to improve some of the most important and useful of the sciences.—By eclipses of the moon the *earth* is proved to be of a *globular* form, the sun to be *greater* than the *earth*, and the *earth* greater than the *moon*. When they are similar in all their circumstances, and happen at considerable intervals of time, they also serve to ascertain the real period of the moon's motion. In geography, eclipses are of considerable use, in determining the longitude of places, and particularly eclipses of the moon, because they are oftener visible than those of the sun, and the same eclipse is of equal magnitude and duration at all places where it is seen. In chronology, both solar and lunar eclipses serve to determine exactly the time of any past event.

For the purpose of finding the longitude of places on the earth, eclipses of Jupiter's satellites are found much more useful than eclipses of the moon; not only on account of their happening more frequently, but on account of their instantaneous commencement and termination.

When Jupiter and any of his satellites are in a line with the sun, and Jupiter between the satellite and the sun, it disappears, being then eclipsed, or involved in his shadow. When the satellite goes behind the body of Jupiter, with respect to a spectator on the earth, it is said to be *occulted*, being hid from our sight by his body, whether in his shadow or not. And when the satellite comes into a position between Jupiter and the sun, it casts a shadow on the face of that planet, which is seen by a spectator on the earth as an obscure round spot.—Lastly, when the satellite is in a line with Jupiter and the earth, it appears on his disc as a round black spot, which is termed a transit of the satellite.

As those phenomena appear at the same moment of *absolute* time at all places on the earth to which Jupiter is then visible, but at different hours of *relative* time, according to the distance between the meridian of the places at which observations are made, it follows that this difference of time converted into degrees will be the difference of longitude between those places.* Suppose, for example, that a person at London observed an eclipse to begin at 11 o'clock in the evening, and that a person at Barbadoes observed the same at 7 o'clock in the evening, it is certain the eclipse was seen by both persons at the same moment of absolute time, although there is four hours difference in their manner in reckoning that time; and this converted into degrees (at the rate of 15 degrees to an hour) is the difference of longitude between these two places—therefore, Barbadoes is 60 degrees *west* from London, the time not being so far advanced there as at London.

Another phenomena, somewhat similar to an eclipse, sometimes takes place, by which the longitude of places may be determined, although not quite so easily, nor, perhaps, so accurately, as by the eclipses of Jupiter's satellites. This is the hiding or obscuring of a fixed star or planet by the moon or other planet, which takes place when the moon or planet is in conjunction with the star.—Appearances of this kind are termed occultations. They are very little attended to except by practical astronomers, who employ them for the correction of the lunar tables, and settling the longitude of places, as already stated.

(To be continued.)

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* A penumbra is the faint shadow produced by an opaque body when opposed to a luminous one.

* *Absolute* time is that which is computed from the same moment; *relative* is that which is computed from different moments.

BOTANICAL NOTICES.

LEAVES.

Leaves are among the most important vegetative organs. They may be said to perform the same office to plants which lungs do to animals, as it is through them that vegetable breathing is carried on. By means of their pores and fine vessels, they absorb and transmit the air and moisture which surround them; and after thus aiding in the nourishment of the very extremities of the plant, they throw off from other pores not merely the superabundant juices, but the air which they had previously taken up, and that in a state infinitely purer, and better adapted to the support of animal existence, than at first; in fact, the very gas, (carbonic acid,) which plants absorb, is injurious to us; and that we want to breathe, which is oxygen, they supply us with in return.

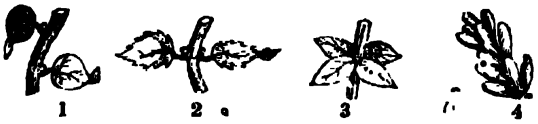
The functions of leaves, therefore, are highly important, and like the finer extremities of the roots require to be renewed from time to time: thus, during the greater part of the summer, fresh leaves are arising—when autumn comes, the whole fall off or decay away, leaving, as is well known, *herbaceous* plants dead, all but the root; and *deciduous* trees bare and leafless.

Leaves have other uses, scarcely of less consequence. Those of the grass tribe by sheathing around it add much to the strength of the young and tender stem. In trees they are so admirably placed as to shield the bud, and often the young flower, not only from external injury, but from the too great heat of summer, and where it is necessary from the chilling winds of winter. This latter property is seen in our evergreens; and in some species of the oak; where the leaves, although dead, still keep their place, till the swelling bud in the spring is ready to supply the tree with a new and living foliage.

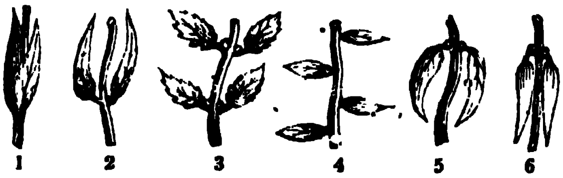
Ordinary leaves are composed, first, of a skin or cuticle, which covers them on both sides; within this is a green pulpy mass, called *cellular tissue* or *parenchyma;* and inside of all is a woody substance, branching out into delicate veins, intended not merely to convey the vegetable juices and secretions, but to strengthen the more pulpy parts of the leaf.

Leaves vary so much in shape and size, that scarcely any two plants (except in particular tribes) have them exactly alike; thus in leaves are very often found sure marks to tell plants from each other. After dividing them into *radical* or root leaves, and *cauline* or stem leaves, they are considered with respect to their position, insertion, shape, surface, and texture.

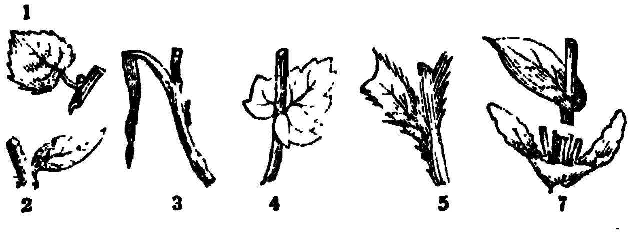
In their situation on the stem they may be either *alternate*, (Fig. 1,) that is, growing singly, first one on one side of the stem and then one on the other —*opposite*, or growing (2,) in pairs—*whirled*, (3,) three, four, or more, growing out of the same part of the stem—and *imbricated*, (4,) when they fold over each other: sometimes they are scattered apparently without order.



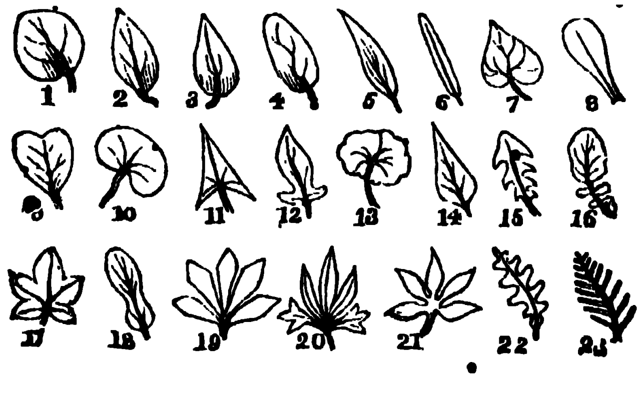
In their manner of growth leaves are either *appressed*, (Fig. 1,) or growing close to the stem—*erect*, (2,) or upright—*patent*, (3,) or spreading out —*horizontal*, (4,)—*reclined*, (5,)—and *dependant*, (6,) or hanging downwards.



In their insertion or manner of attachment a leaf is called *stalked*, (Fig. 1,) if with a distinct stalk—*sessile*, (2,) if joined at once to the stem—*vaginate*, (3,) if sheathing round the stem—*clasping*, (4,) if the base closed around it—*decurrent*, (5,) if running down—*perfoliate*, (6,) if the stem run through it—and *connate*, (7,) whenever the base of two leaves are joined together.

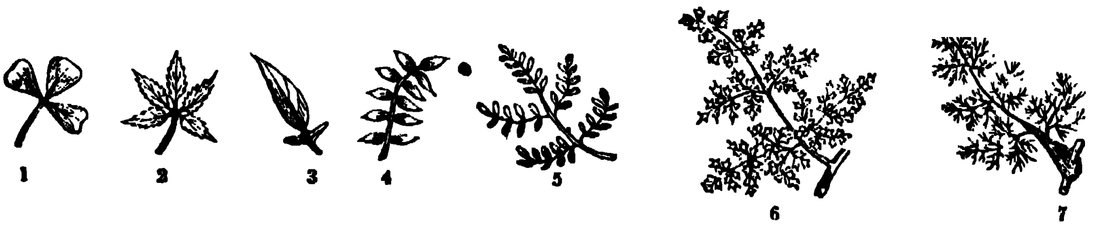


The shapes of leaves are almost endless; they are either simple, compound, or doubly compound. Simple leaves may be, 1 *round*—2 *oval*—3 *ovate*, or egg shaped—4 *oblong*—5 *lanceolate*—6 *linear*—7 *cordate*, or heart shaped—8 *spathulate*—9 *obcordate*, that is, cordate with the wider part away from the stalk—10 *reniform* or kidney-shaped—11 *sagittate* or arrow shaped—12 *hastate* or like the head

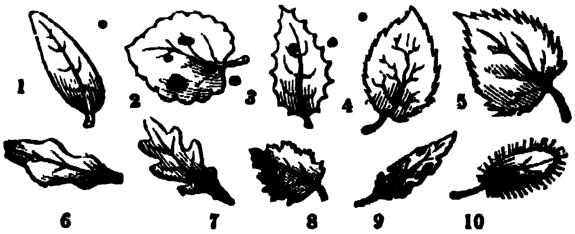


of a halbert—13 *peltate*, that is, with the stalk growing from the middle of it—14 *deltoid*; or something like the Greek letter Delta—15 *runcinate*—16 *lyrate*, or guitar shaped—17 *lobed*—18 *fiddle shaped*—19 *digitate*, or fingered—20 *pedate*—21 *palmate*, or like a hand—22 *pinnatifid*, that is, with lobes cut down nearly to the midrib—23 *pectinate*, cut like the teeth of a comb. The last eight are lobed leaves.

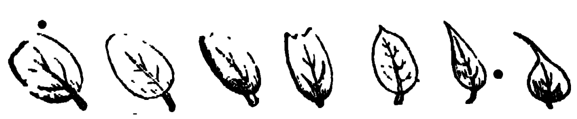
Compound leaves are formed of many simple ones joined together. They are called *binate*, *ternate*, (Fig. 1,) *quaternate*, *quinate*, (2,) &c., as there may be two, three, four, five, or more, separate portions on the general leaf stalk—*winged*, (3,) when there are two distinct projections below the blade of the leaf, as in the orange—*pinnate*, (4,) when many are joined so as to make two rows—and *doubly pinnate*, (5,) where several pinnate leaves are united; so also a leaf may be *doubly ternate*, or even *thrice ternate*. All instances of this kind form *doubly compound* leaves, though the last term is mostly applied to such as are too much divided to have their parts readily counted (as in Fig. 6). When these parts are fine, like hairs, the leaf is called *capillaceous* (Fig. 7).



The edges of leaves are another mark of distinction, whether they be *entire*, (Fig. 1,) that is, without notches—*crenate*, (2,) or scalloped—*toothed*, (3,)—*serrate*, (4,) or cut like a saw—*doubly serrate*, (5,) where a large and a small cut follow each other—*waved*, (6,)—*indented*, (7,)—*eroded*, (8,) or looking as if it were knawed—*crisped*, (9,) or curled—*ciliated*, (10,) that is, with hairs around it, as to an eye-lash.



The points of leaves are of no less consequence. They are known as *truncate*, (Fig. 1,) if cut off short—*obtuse*, (2,) or blunt pointed—*emarginate*, (3,) having a notch at the end—*trident pointed*, (4,)—*cuspidate*, (5,) or tapering into a hard point—*tapering*, (6,)—and *hair pointed*, (7,) where the leaf terminates in a long, weak, and fine point.



Our daily observation informs us of many particulars besides these relative to this important organ. We are accustomed to witness leaves covered with thorns, strings, hairs and wrinkles.—We know that the furze bush is scarcely furnished with leaves at all—numerous thorns supplying their place. Many plants can boast only of a few scales, and some not even these imperfect substitutes;—thus the leafless dodder twines around the flax and the heath, choking them by its embrace, and starving them by the absorption of the juices they had stored up for their own use. On the other hand, in tropical regions the leaves of many vegetables are of enormous size—that of the talipot tree of Ceylon is often 30 or 40 feet in circumference, and supported by a stalk 12 feet long—a single leaf being capable of shielding many persons from the sun and rain. The leaves of the date tree, of the banana, and of the cocoa nut, are almost equally magnificent. In our own country we witness nothing equal in magnitude to these; but we have instead of it richness of tint, and an endless variety of appearance. In the hotter regions trees are evergreen, always putting forth fresh leaves, and losing their older ones. The forests, therefore, of countries like these are of a more uniform appearance than in the temperate regions. With us, although in the winter our woods are bare, yet during the remaining seasons we have an ever-varying succession of beauty, from the lively green, which the tender leaves assume in the spring, through the luxuriant and dark foliage of the summer, to the rich and mellow autumnal tints which precede "*the fall of the leaf*," casting so bright a charm around the dying landscape, and contrasting with each other, no less in their decay, than they did in the previous times, when buds were opening, and flowers shining in their fresh and fragrant beauty.

THE SUN NOT A GLOBE OF FIRE, AND PROBABLY INHABITED.

The sun appears to be nothing else than a very eminent, large, and lucid planet, evidently the first, or in strictness of speaking, the only primary one of our system; all others being truly secondary to it. Its similarity to other globes of the solar system with regard to its solidity, its atmosphere, and its diversified surface, the rotation on its axis, and the fall of heavy bodies, leads us on to suppose that it is most probably also inhabited, like the rest of the planets, by beings whose organs are adapted to the peculiar circumstances of that vast globe.

It may not, however, be amiss to remove a certain difficulty which arises from the effect of the sun's rays on our globe. The heat which is here, at the distance of ninety-five millions of miles, produced by these rays, is so considerable, that it may be objected that the surface of the globe of the sun itself must be scorched up beyond all conception. This may be very substantially answered by many proofs drawn from natural philosophy, which show that heat is produced by the sun's rays only when they act on a calorific medium; they are the cause of the production of heat, by uniting with the matter of fire which is contained in the substances that are heated; as the collision of flint and steel will inflame a magazine of gunpowder by putting all the latent fire it contains into action. But an instance or two of the manner in which the solar rays produce their effect will bring this home to our most common experience.

On the tops of mountains of a sufficient height, at an altitude where clouds can very seldom reach, to shelter them from the direct rays of the sun, we always find regions of ice and snow. Now if the solar rays themselves conveyed all the heat we find on this globe, it ought to be the hottest where their course is least interrupted. Again, our aeronauts all confirm the coldness of the upper regions of the atmosphere; and since therefore even on our earth, the heat of any situation depends on the aptness of the medium to yield to the impression of the solar rays, we have only to admit, that on the sun itself, the elastic fluids composing its atmosphere, and the matter on its surface, are of such a nature as not to be capable of any excessive affection from its own rays, and this seems to be proved by the copious emission of them; for if the elastic fluids of the atmosphere, or the matter contained on the surface of the sun were of such a nature as to admit of an easy chemical combination with its rays, their emission will be much impeded.

Another well-known fact is, that the solar focus of the largest lens thrown into the air will occasion no sensible heat in the place where it has been kept for a considerable time, though its power of exciting combustion, when proper bodies are exposed, should be sufficient to fuse the most refractory substances.—*Herschel.*

ESSENTIAL OR VOLATILE OILS.

(Resumed from page 111, and concluded.)

Oil of Lemons, is extracted by pressure from the yellow peel of the fruit of the lemon, or *citrus medica*. In this state it is a yellowish fluid, having a specific gravity of 0·8517; but when distilled along with water till three-fifths of the oil have come over, it is obtained in a colorless state, and of a specific gravity of 0·847 at 72° F. This oil does not become concrete till cooled to 4° below 0° F.

The oil of lemons has a very agreeable smell of the fruit, which is injured by distillation. It is soluble in all proportions in anhydrous alcohol, but only 14 parts dissolve in 100 of spirits of wine of specific gravity 0·837. This oil, especially when distilled, forms with muriatic acid similar camphorated compounds with oil of turpentine, absorbing no less than 280 volumes of acid gas.

Oil of lemons kept long, in ill-corked bottles, generates a quantity of stearessence, which when dissolved in alcohol, precipitated by water, and evaporated, affords brilliant, colorless, transparent needles. Some acetic acid is also generated in the old oil. According to Brande, the specific gravity of oil of lemons is 0·8786.

The Oil of Mace, lets fall, after a certain time, a concrete oil under the form of a crystalline crust, called by John *myristicine*.

The Oil of Orange Flowers, called *neroli*, is extracted from the fresh flowers of the *citrus aurantium*. When recently prepared it is yellow; but when exposed for two hours to the rays of the sun, or for a longer time to diffuse daylight, it becomes of a yellowish-red. It is very fluid, lighter than water, and has a most agreeable smell. The aqueous solution known under the name of orange-flower water, is used as a perfume. It is obtained either by dissolving the oil in water, or by distilling with water the leaves either fresh or salted; the first being the stronger, but the last being the more fragrant preparation. Orange-flower water obtained by distillation, contains besides the oil, a principle which comes over with it, of a nature hitherto unknown; it possesses the property of imparting to water the faculty of becoming red with a few drops of sulphuric acid. The water formed from the oil alone is destitute of this property. The intensity of the rose-color is a test in some measure of the richness of the water in oil.

The Oil of Parsley, is extracted from the *apium petroselinum*. It is of a pale yellow color, having the smell of the plant, and consists of two oils separable by agitation in water. Its liquid part floats upon the surface in a very fluid form; its stearessence, which falls to the bottom, is butyraceous and crystallises at a low temperature. This concrete oil melts at 86° F.

The Oil of Pepper, is extracted from the *piper nigrum*. In the recent state it is limpid and colorless, but by keeping it becomes yellow. It swims upon the surface of water. In odour it resembles pepper, but is devoid of its hot taste.

The Oil of Peppermint, is extracted from the *mentha piperita*. It is yellowish, and endued with a very acrid burning taste. Its specific gravity is 0·920. At 6° or 7° below 0° F., it deposits small capillary crystals. After long keeping it affords a stearessence resembling camphor, provided the oil had been obtained from the dry plant gathered in flower, but not from distillation of the fresh plant. When artificially cooled, it yields 6 per cent. of stearessence, which crystallises in prisms with three sides, has an acrid somewhat rank taste, is soluble in ether and alcohol, and is thrown down from the latter solution by water in the form of a white powder. Peppermint water is characterized by the sensation of coolness which it diffuses in the mouth.

The Oil of Pimento, is extracted from the envelopes of the fruits of the *myrtus pimenta*, which afford 8 per cent. of it. It is yellowish, almost colorless, of a smell analogous to that of cloves, an acrid burning taste, and a specific gravity greater than water. Nitric acid makes it first red, and after the effervescence, of a rusty brown hue. It combines with the salifiable bases, like oil of cloves.

The Oil of Rhodium, is extracted from the wood of the *convolvolus scoparius*. It is very fluid, and has a yellow color, which in time becomes red. It has somewhat of the rose odour, and is used to adulterate the genuine *otto*. Its taste is bitter and aromatic, which it imparts to the otto as well as its fluidity.

The Oil of Roses, called also the *attar* or *otto*, is extracted by distillation from the petals of the *rosa centifolia* and *sempervirens*. Our native roses furnish such small quantities of the oil, that they are not worth distilling for the purpose. The best way of operating is to return the distilled water repeatedly upon fresh petals, and eventually to cool the saturated water with ice; whereby a little butyraceous oil is deposited. But the oil thus obtained has not a very agreeable odour, being injured by the action of the air in the repeated distillations. In the East Indies, the attar is obtained by stratifying rose leaves in earthen pans in alternate layers, with the oleiferous seeds of a species of digitalis, called *gengeli*, for several days, in a cool situation. The fat oil of the seed absorbs the essential oil of the rose. By repeating this process with fresh leaves and the same seed, this becomes eventually swollen, and being then expressed furnishes the oil. The turbid liquid thus obtained is left at rest, in well-closed vessels, where it gets clarified. The layer of oil that floats on the top is then drawn off by a capillary cotton wick, and subjected to distillation along with water, whereby the volatile otto is separated from the fat seed-oil.

The oil of roses is colorless, and possesses the smell of roses, which is not however agreeable, unless when diffused, for in its concentrated state it is far from pleasant to the nostrils, and is apt to occasion headaches. Its taste is bland and sweetish. It is lighter than water, and at the temperature of 92°, its specific gravity compared to that of water at 60° is 0·832. At lower temperatures it becomes concrete and butyraceous; and afterwards fuses at 90°. It is but slightly soluble in alcohol; 1000 parts of this liquid at 0·806 dissolving only 7½ parts at 58° F. This oil consists of two parts, the stearessence and oleiessence; the latter being the more volatile odoriferous portion.

The Oil of Rosemary, is extracted from the *rosmarinus officialis*. It is as limpid as water, has the smell of the plant, and in other respects resembles oil of turpentine. The oil found in commerce has a specific gravity of 0·911, which becomes 0·8886 by rectification. It boils at 320 F. (occasionally at 329°.) It is soluble in all portions in alcohol of 0·830. When kept in imperfectly closed vessels, it deposits a stearessence to the amount of one-tenth of its weight, resembling camphor. It is sometimes adulterated with oil of turpentine, a fraud easily detected by adding anhydrous alcohol, which dissolves only the oil of rosemary.

The Oil of Saffron, is extracted from the *stigmata* of the *crocus sativus*. It is yellow, very fluid, falls to the bottom of water, diffuses the penetrating odour of the plant, and has an acrid and bitter taste. It is narcotic.

The Oil of Sassafras, is extracted from the woody root of the *laurus sassafras*. It is colorless, but at the end of a certain time it becomes yellow or red. It has a peculiar, sweetish, pretty agreeable, but somewhat burning taste. Its specific gravity is 1·094. According to Bonastre, this oil separates by agitation with water into an oil lighter and an oil heavier than this fluid. When long kept, it deposits a stearessence in transparent and colorless crystals, which have the smell and taste of the liquid oil.

The Oil of Savine, is extracted from the leaves of the *juniperus sabina*. It is limpid, and has the odour and taste of the plant, which is one more productive of volatile oil than any other.

The Oil of Tansy has a specific gravity of 0·946, the penetrating odour of the *tanacetum vulgare*, with an acrid and bitter taste.

Oil of Turpentine, commonly called essence of turpentine. It is extracted from several species of turpentine, a semi-liquid resinous substance which exudes from certain trees of the *pine* tribe, and is obtained by distilling the resin along with water. This oil is the cheapest of all the volatile species, and, as commonly sold, contains a little resin, from which it may be freed by re-distillation with water. It is colorless, limpid, very fluid, and has a very peculiar smell. Its specific gravity at 60° is 0·872; that of the spirit on sale in the shops is 0·876. This oil always reddens litmus paper, because it contains a little succinic acid.

100 parts of spirits of wine, of specific gravity 0·84, dissolve only 13½ of oil of turpentine at 72° F. When agitated with alcohol at 0·830 the oil retains afterwards one-fifth of its bulk of the spirit; hence this proposed method for purifying oil of turpentine is defective. The oil if left during four months in contact with air is capable of absorbing 20 times its bulk of oxygen gas. One volume of rectified oil of turpentine absorbs at the temperature of 72°, and under the common atmospheric pressure, 163 times its volume of muriatic acid gas, provided the vessel be kept cool with ice. This mixture being allowed to repose for 24 hours, produces out of the oil from 26 to 47 per cent. of a white crystalline substance, which subsides to the bottom of a brown, smoking, translucent liquor. Others say that 100 parts of oil of turpentine yield 110 of this crystalline matter, which was called by Kind, its discoverer, artificial camphor, from its resemblance in smell and appearance to this substance. Both the solid and the liquid are combinations of muriatic acid and oil of turpentine; indicating the existence of a stearine and an oleine in the latter substance. The liquid compound is lighter than water, and is not decomposed by it, nor does it furnish any more solid matter when more muriatic gas is passed through it. The solid compound, after being washed first with water containing a little carbonate of soda, then with pure water, and finally purified by sublimation with some chalk, lime, ashes, or charcoal, appears as a white, translucent, crystalline body, in the form of flexible, tenacious needles. It swims upon the surface of water, diffuses a faint smell of camphor, commonly mixed with that of oil of turpentine, and has rather an aromatic than a camphorated taste. It does not redden litmus paper. Water dissolves a very minute quantity; but cold alcohol of 0·806 dissolves fully one-third of its weight, and hot much more, depositing, as it cools, this excess in the form of crystals. The solution is not precipitated by nitrate of silver, which shows that the nature of the muriatic acid is perfectly masked by the combination. It is composed, in 100 parts, of 76·4 carbon, 9·6 hydrogen, and 14 muriatic acid. The muriatic acid, or chlorine may be separated by distilling an alcoholic solution of the artificial camphor 12 or 14 times in succession with slaked lime.

Oil of turpentine is best preserved in casks inclosed within others, with water between the two. Its principal use is for making varnishes, and as a remedy for the tape-worm.

The Oil of Thyme, is extracted from the *thymus serpyllum*. It is reddish yellow, has an agreeable smell, and, after being long kept, it lets fall a crystalline stearessence. It is used merely as a perfume.

The Oil of Wormwood, is extracted from the *artemisia absinthium*. It is yellow, or sometimes green, and possesses the odour of the plant. Its taste resembles that of wormwood, but without its bitterness. Its specific gravity is 0·9703, according to Brisson, and 0·9725, according to Brande. It detonates with iodine when it is fresh. Treated with nitric acid of 1·25 specific gravity, it becomes first blue, and, after some time, brown.

MEMORANDA.

Iron.—Every person knows the manifold uses of this truly precious metal; it is capable of being cast in moulds of any form; of being drawn out into wires of any desired strength or fineness; of being extended into plates or sheets; of being bent in every direction; of being sharpened, hardened, and softened at pleasure. Iron accommodates itself to all our wants, our desires, and even our caprice; it is equally serviceable to the arts, the sciences, to agriculture, and war; the same ore furnishes the sword, the ploughshare, the scythe, the pruning-hook, the needle, the graver, the spring of a watch or of a carriage, the chisel, the chain, the anchor, the compass, the cannon, and the bomb. It is a medicine of much virtue, and the only metal friendly to the human frame. The ores of iron are scattered over the crust of the globe with a beneficent profusion, proportioned to the utility of the metal; they are found under every latitude and every zone; in every mineral formation, and are disseminated in every soil.—*Dr. Ure's Dictionary of Manufactures.*

Sea Worms.—These animals, which are so pernicious to our shipping, appear to have the same office allotted to them in the waters, which the termites or white ants have on the land. Were it not for their rapacity, many rivers, and parts of the ocean itself would be choked with the bodies of trees which are annually carried down by the rapid torrents, and many of them would last for ages, and probably be productive of evils, of which we cannot in the present harmonious state of things form any idea; whereas now, being consumed by these animals, they are easily broken to pieces by the waves, and their entire dissolution is afterwards rapidly effected by a variety of causes.

Human Time Piece.—The following singular account appears in a recent number of a valuable French work, the "Bibliotêque Universelle."

J. D. Chevalley, a native of Switzerland, aged sixty-seven, has arrived at an astonishing degree of perfection in reckoning time by an *internal movement.* In his youth he was accustomed to pay great attention to the ringing of bells, and vibrations of pendulums, and by degrees he acquired the power of continuing a succession of intervals exactly equal to those which the vibrations or sounds produced. Being on board the steam-boat on the Lake of Geneva, on July 14, 1823, he engaged to indicate to the crowd about him the lapse of a quarter of an hour, or as many minutes and seconds as any one chose to name, and this during a conversation the most diversified with those standing by; and farther, to indicate by the voice the moment when the hand passed over the quarter minutes, or half minutes, or any other sub-division previously stipulated, during the whole course of the experiment. This he did without mistake, notwithstanding the exertions of those about him to distract his attention, and clapped his hand at the conclusion of the time fixed. His own account of it is thus given:—"I have acquired by imitation, labor, and patience, a movement which neither thoughts nor labor, nor any thing can stop. It is similar to that of a pendulum which at each motion of going and returning gives me the space of three seconds, so that twenty of them make a minute, and these I add to others continually."

Humming of Gnats.—It appears very probable that the humming noise emitted by the gnat when flying about in a dark room is useful to the insect itself, for, as it would be differently modulated according to its distance from, or nearness to, surrounding objects, it may have the effect of preventing its injuring itself by knocking against obstructions to its flight. As a proof of the great difference in sounds arising from even but trifling causes, we have only to take a card in hand and whistle against its edge at a little distance, and then a greater distance, and then against its flat surface at a greater or less distance, and we shall observe that the tone widely differs under each of these circumstances. Now, if we suppose that the gnat knows, from either instinct or experience, that sounds thus differ according to such circumstances as the above, it may learn its situation in a dark room by the variation produced upon its piping noise (which may thus be as serviceable to it in the dark as its sight in the day time), and avoid breaking its wings, or otherwise hurting itself by flying against anything in its way. In the same manner, probably, one may explain the utility of the humming of the cockchafer (*Melontha vulgaris*), the dung-beetle (*Geotrupes stercorarins*), and many other insects.

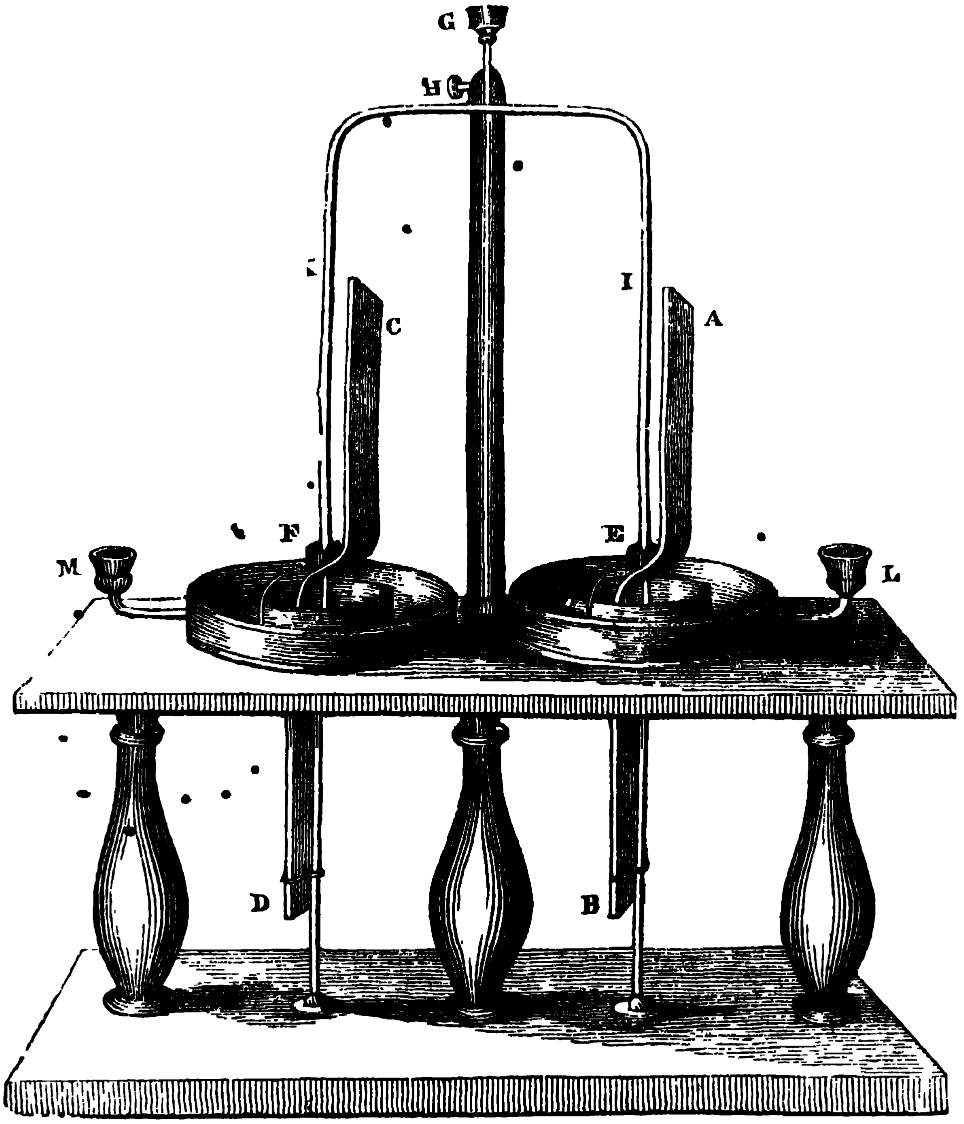
The Velocities of Wind.—Mr. John Smeaton, the late celebrated engineer, has given in the "Philosophical Transactions," vol. 51, the velocities of wind, corresponding to the usual denominations in our language. These are founded in a great number of observations made in the course of his practice in erecting wind-mills, and are as follow:—

Light airs.. from..	1	to	3 miles	per hour.
Breeze	4	to	5 miles	do.
Brisk gale	10	to	15 miles	do.
Fresh gale	20	to	25 miles	do.
Strong gale	30	to	35 miles	do.
Hard gale........	40	to	45 miles	do.
Storm	50	to	60 miles	do.
Hurricane	80	to	100 miles	do.

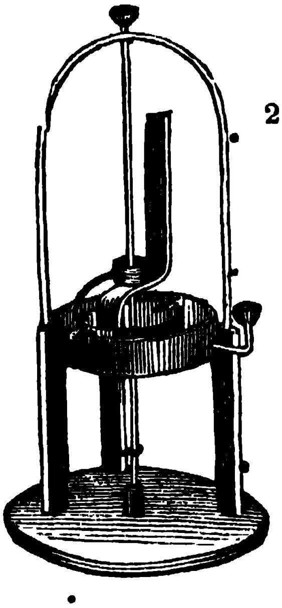
The Light of the Moon and Planets is considered by Professor Leslie to be caused by phosphorescent matter, and not by mere reflection from the sun. The light falling from the sun upon the moon's surface appears to him to be almost entirely absorbed, and exerts there a power to cause the projection of a still greater quantity of luminous particles, which had previously lain combined with the substance, which he supposes bears a resemblance to the sulphate of barytes.

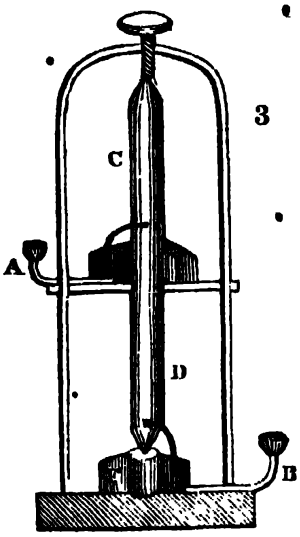
Bleaching Ivory.—Antique works in ivory that have become discolored may be brought to a pure whiteness by exposing them to the sun under glasses. It is the particular property of ivory to resist the action of the sun's rays, when it is under glass; but when deprived of this protection, to become covered with a multitude of minute cracks. Many antique pieces of sculpture in ivory may be seen, which, although tolerably white, are, at the same time, defaced by numerous cracks; this defect cannot be remedied; but, in order to conceal it, the dust may be removed which has insinuated itself into the fissures, by brushing the work with warm water and soap, and afterwards placing it under glass. Antique works in ivory that have become discolored, may be brushed with pumice stone, calcined and diluted, and while yet wet placed under glasses. They should be daily exposed to the action of the sun, and be turned from time to time, that they may become equally bleached; if the brown color be deeper on one side than the other, that side will, of course, be for the longest time exposed to the sun. The bleaching may be accelerated by frequently repeating the operation just described.—*Repertory of Arts*

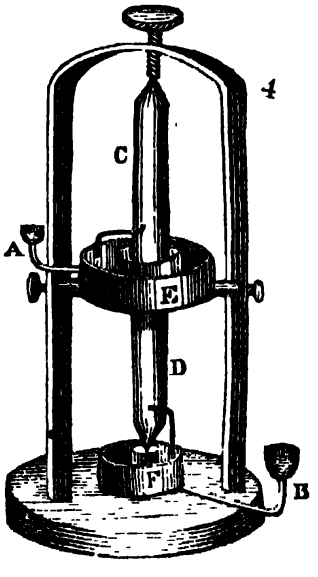
Fig. 1.



ELECTRO-MAGNETISM.







ELECTRO-MAGNETISM.

(*Continued from page* 378, *vol.* ii.)

The last paper upon this subject gave an account of various electro-magnetic rotations, produced upon wires conveying the electric fluid along them, aided by the effects of the propinquity of a magnet. The present article continues the subject by showing that magnets themselves, if made free to revolve, and subjected, in particular ways, to electrical currents, will also revolve upon their axes.

Ampère was the first who succeeded in accomplishing the revolution of a magnet on its own axis. His apparatus for this purpose was a magnet, suspended vertically on a point, and with a mercury cup at the upper end, it being free to move around its centre. The lower half of the magnet was immersed in quicksilver—connected with which quicksilver, was a second mercury cup. As soon as connection was made between the poles of the electro-magnetic battery and the mercury cups, the fluids passed through the upper half of the magnet, and occasioned it to rotate. The principal defect of the above arrangement was the weight of the large quantity of mercury employed, and the friction it occasioned against the sides of the magnet, so retarded the motion, that a very powerful battery was indispensable.

The same phenomenon has been exhibited in various ways; the principle on which it depends is, that the electric current should pass through one half of the magnet only, so as to act exclusively on the pole which is situated in that half, and afterwards be diverted from the magnet, and made to pass away in such a direction as that it shall not affect the other half of the magnet. In the experiment of M. Ampère above related, the electric current, after traversing the upper half of the magnet, passes into the mercury, and being diffused through it, acts in no sensible degree on the lower pole of the magnet, and does not interfere with the rotation produced by its influence on the upper pole.

The same object is attained in the following manner, by an apparatus represented in fig. 3, and in section in fig. 4; a magnet, pointed at both ends, is supported below by an agate cup, fixed on a stem rising from the bottom of the stand; whilst its upper point is lightly pressed upon by a screw with a milled head, passing through a screwed hole at the top of an arched head, which forms part of the sustaining frame-work of the apparatus, near the middle of the magnet. This frame supports a stage in the form of a ring, through the centre of which the magnet passes freely, and carrying a circular cistern of mercury, which also surrounds the magnet, without touching it. A similar cistern of mercury surrounds the lower stem, which supports the agate cup. A copper wire projecting into the interior of each of these cisterns, passes out through its sides, and being bent upwards, terminates in a small cup holding a little mercury, for effecting the communication with the electro-magnetic battery by wires in the usual manner. A small wire pointed and amalgamated at its end, is affixed to the middle of the magnet, immediately above the cistern, and is bent so as just to dip into the mercury contained in the cistern. A similar wire, proceeding from the lower end of the magnet, is made to dip into the mercury contained in the lower cistern. The lower half only of the magnet being thus made to form part of the galvanic circuit—which is continuous from one cup through the cistern of mercury, the wire belonging to the magnet, the magnet itself, the other wire, the other cistern of mercury, and the wire terminating in the other cup, receives the exclusive influence of the electric current which passes through it, and begins to rotate with considerable velocity round the axis which is constituted by its upper and lower points of support.—The degree of rotatory effect will depend very much on the delicacy of the suspension of the magnet, so that the friction at the points may be as small as possible.

Different forms have been given to the magnet in the above apparatus, all, however, having the same obvious intention of diminishing friction and balancing the magnet equally upon a centre. One of the more successful as well as the more effective of these pieces of apparatus, is that shown in fig. 2, and which will be readily understood by the preceding descriptions, and by that which follows, explaining the action of a double apparatus, by which rotations in opposite directions may be exhibited at the same time, and, by the same current, by placing the poles of the one in a contrary direction to those of the other magnet.

Fig. 1, represents this double apparatus. Two bar magnets A B and C D, are bent, so as to form a shoulder in the middle, in which are small holes drilled, by which they are suspended on pivots, and made free to revolve. On the upper side of the shoulder small cups E and F are attached to contain mercury. From each of these cups a small wire is bent downwards, to dip into the mercury contained between the concentric cylinders on the stand; proceeding from the upright stem is a brass wire, I K, of a staple form, whose ends dip into the small cups on the bendings of the magnets; the circuit is formed by dipping the connecting wires into the cup G at the top, and the cups L M on each side of the apparatus. The magnets then commence a very rapid revolution in the same or contrary directions, according as dissimilar or similar poles of the battery are employed. H is a screw for adjusting the brass wire I K, so that its extremities may communicate properly with the small cups.

By this mode of making the experiment, the whole length of both the magnets is exposed to view, and by having the north pole of the one, and south pole of the other subjected to similarly electrified wires, the different directions of rotation of dissimilar poles can be observed at one and the same time.

(*To be continued.*)

LAW OF PATENTS.

(*Resumed from page* 108, *and concluded.*)

Enrolment.—In England, a patent is void unless it is enrolled. The time allowed for the enrolment is now generally confined to one month. Enrolment cannot be dispensed with, though it be to keep the specification secret. After a patent has passed, the time for enrolment cannot be enlarged without an act of parliament. In the United States of America, the patent, after the seal of the United States of America is affixed, is recorded in a book kept for the purpose.

Infringement.—Whether any act is really an infringement of the patent, is a question for the jury. The using the least part of the manufacture is an infringement. In Manton *v.* Manton, the infringement consisted in making a perforation in the hammer of a gun in a direction a little different from that in the patent article. If the article manufactured be of a different form, or made with slight and immaterial alterations or additions, if the manufactures are really and substantially the same, the patentee is entitled to a remedy, as where the position of the different parts of a steam engine were reversed. Where several independent improvements are made in the same machine, and a patent is procured for them in the aggregate, the patentee is entitled to recover against any person who shall use any one of the improvements so patented, notwithstanding there shall have been no violation of the other improvements.—*Remedy for Infringement.* The remedies for infringement, in England, are by an action at law for the damages, or by proceedings in equity for an injunction and account.—The remedy sought in equity is for instant relief, and it is often preferable to proceed in equity before a suit is commenced at law. In the United States of America, the circuit court has original cognizance, as well in equity as at law, in regard to patents, and may grant injunctions. The damages for a breach of the patent right, in the United States of America, are three times the actual damage sustained by the patentee: the jury are to find single damages, the court are to treble them. In France, the patentee, in case of infringement, shall recover the damage he may sustain, and a penalty for the benefit of the poor, not to exceed 3000 francs, and double in case of second offence.—*Repeal.* If a patent be void, in England, the king may have a *scire facias* to repeal his own grant. All persons are injured by the existence of an illegal patent for an invention, and every one is therefore entitled to petition for a *scire facias* to have it cancelled. Patents are repealed, in the United States of America, by a process in the nature of a *scire facias.*—*Who may obtain a Patent.* Aliens who have resided two years in the United States of America are allowed to obtain patents under the act of 1800, on their making oath that the invention has not, to the best of their knowledge or belief, been used in any country before. The English law has no restrictions on this head, and it is every day's practice to grant patents for new inventions to Americans and other foreigners.

The foregoing portion of this article is modified from a very excellent article in the "Popular Encyclopedia;" and what follows from the "Companion to the Almanac," for 1836.

An Act has been passed in a late Session of Parliament to do away with some of the defects with which our antiquated Patent Laws are encumbered; and, although it does not pretend to an entire removal of the causes of complaint, yet, considering the admitted difficulties of the case, and the very objectionable nature of some of the former propositions for amendment, we are not sorry that the work of improvement has been begun with caution; at the same time we wish to consider what has been done only as a beginning, and hope it will lead the way to a general amelioration.

One great grievance of the system was the destruction of all right to a patent which resulted from an inadvertent claim put in to any part of an invention which might not actually be new, although that circumstance should be unknown to the inventor, and even although the part claimed should be a small and unessential portion of the whole invention. To make this matter clear, it must be stated that, in explaining the nature of an invention, such as a machine for instance, the patentee is compelled to describe the construction of his invention in the fullest detail, so as to enable an ordinary workman to construct a similar machine. As, in every such new invention, certain parts must also necessarily be well known, certain wheels and levers will be like wheels and levers in other machines;—and as to these wheels and levers the patentee can have no exclusive right, he is expected to declare in his specification what parts of the machine he claims as his own invention. To these alone he has exclusive right; all other parts are public property, and may be used by any one. Thus far all is right; if it were otherwise, a patentee might be allowed a right to what is not his own. The grievance complained of is, that if a patentee should inadvertently lay claim to any part of his new invention, which part might afterwards be found not original, he lost not only his right to an exclusive use of that one part, but to the entire invention, however new it might be. He was thus cooped up in a dilemma; if he did not claim the whole of his invention, from a fear of overclaiming, he of course lost his right to that which he did not claim; if, on the contrary, he claimed all which was his own, and it should be found that some part was not original, then he lost his whole patent. The motive to this severity seems to have been the wish to prevent, by a penalty, an unprincipled schemer from endeavouring to appropriate to himself more than his own. But while the schemer was punished, the honest inventor was often a sufferer. A new machine might have great merit, it might in principle and action be perfectly new; but some of its details might have been used in some other machine now in disuse, quite unknown to the inventor. This is discovered by some rival manufacturer, and the patentee loses his right. By the act now passed, this grievance is done away with; if a patentee should be in the situation supposed, if he should find that some portion of his invention has been anticipated, he may now, on a proper representation, obtain leave to enter and enrol a disclaimer of such portion, and remain in the situation he would have been in, had no such claim ever been put forward.

It has been objected to this alteration, that advantage may be taken of it by a dishonest schemer, who may take out a patent for an invention not his own, and then, as he finds himself discovered, enter a disclaimer, first to one part and then to another, as such parts are objected to, and in the mean time reap all the advantage of his patent, as though the invention were his own. This, we imagine, is an impossible occurrence: it must be remembered that the enrolment of the disclaimer is not a matter of right, that it may be refused by the Attorney-General, unless a sufficient cause is alleged for the alteration, and that, in cause of fraud, it would undoubtedly be refused. There is also another check, and a strong one, against such a practice; the disclaimer cannot be received in evidence, in case of an action brought before such disclaimer was enrolled. A patentee, therefore, who should make an overclaim, and against whom an action should be brought in consequence of that overclaim, will, as far as that action goes, stand precisely in the situation he would have stood in before the new act was passed. He will be liable to the same penalties, and be put to the same expense in the suit.—The only difference is, that he will be enabled to protect himself from the loss of his whole patent in such a case, and will stand upon his own right in future. Now, an honest patentee will, it is true, suffer in the immediate action the penalty of his inadvertence, but no more. The dishonest one will render himself liable to the same penalty, as often as he shall attempt to make use of any right given him by a fraudulent claim.

The second clause enacts, that if a patentee shall have re-produced some old invention, believing himself to be the inventor, it shall be in the power of the crown, upon a recommendation of the Judicial Committee of the Privy Council, to continue the patent to the patentee, wherever it shall appear that the invention has not been publicly and generally used. It is feared by some persons that all kinds of old inventions will be brought up again and promulgated as new, under favor of this clause, and that every body will be taking out patents for old and abandoned projects. This appears very absurd. To say nothing of the expense of taking out patents, and the almost certainty of their being useless to the patentee (for we may be well assured that in ninety-nine cases out of a hundred the inventions would not have been abandoned if they had not been useless), there are so many checks against the continuance of such patent by the crown to any but a *bonâ fide* re-inventor, that few persons will feel inclined to rake out old books for the purpose of picking up lost inventions. If any person should be lucky enough to re-produce an invention of value abandoned from any cause, and generally forgotten, we see no harm in his having the monopoly of its use for a few years as a recompense for his bringing to light a valuable idea, though we would rather he should be entitled to it without any misrepresentation.

The third clause contains a provision against the repeated vexatious actions by which a patentee might be put to enormous law expenses under the former act. Before the passing of the new law, although an action respecting the validity of a patent might be decided in favor of the holder of the patent, this verdict was no bar to a future action, nor to any number of future actions. Although nothing new could be alleged, although it was but going over the same ground again and again, the patentee might be compelled year after year to defend himself against fresh actions to his great injury, perhaps to his ruin. The clause enacts, that in any action respecting the validity of a patent, if a verdict pass in favor of a patentee, the certificate of the judge who tried the action may be adduced in evidence on any future action; and if the verdict in such subsequent action be given in favor of the patentee, he shall receive treble costs.

By the fourth clause, an extension of the term of a patent, not exceeding seven years, may be granted by his Majesty, on a recommendation of the Judicial Committee of the Privy Council, who may call and examine witnesses in the case of a petition for extension. This is decidedly an improvement; the term of fourteen years granted indiscriminately by every patent, is too short in some cases to render any profit to an inventor, and this chiefly in those inventions of great value which require time to introduce. We may instance Watt's improvements on the steam engine, which, from prejudice and other causes, were hardly in general use when the term granted by his patent had expired. By the old act, no extension could be obtained without an application to Parliament, which was attended with so many difficulties that it has been rarely resorted to.

The fifth and sixth clauses refer to the manner of conducting trials for infringement of patent rights, and regulate the costs in such actions. The last clause inflicts a penalty upon any person putting the name or mark of a patentee upon any article without his permission.

Here follows a more detailed abridgement of the act. *An Act to amend the Law touching Letters Patent for Inventions.* [5 and 6 Will. IV. c. 83. —10th September, 1835.]

1. Reciting that it is expedient to make certain additions to, and alterations in, the present law touching letters patent for inventions, as well for the better protecting of patentees in their rights, as for the more ample benefit of the public: enacts that any person having obtained letters patent for any invention, may enter with the clerk of the patents of England, Scotland, or Ireland, respectively, as the case may be, having first obtained the leave of his Majesty's attorney-general or solicitor-general in case of an English patent, of the lord advocate or solicitor-general of Scotland in the case of a Scotch patent, or of his Majesty's attorney-general or solicitor-general for Ireland in the case of an Irish patent, certified by his fiat and signature, a disclaimer of any part of his specification, or a memorandum of any alteration therein, not being such as shall extend the exclusive right granted by the said letters patent; and which, when filed, shall be deemed part of such specification; but a caveat may be entered as heretofore; and such disclaimer shall not affect actions pending at the time; and the attorney-general may require the party to advertise his disclaimer.

2. Where a patentee is proved not to be the real inventor, though he believed himself to be so, he may petition his Majesty in council to confirm his letters patent or grant new ones; and the said petition shall be heard before the judicial committee of the privy council, who, on being satisfied that such patentee believed himself to be the first and original inventor, and that such invention had not been generally used before the date of such first letters patent, may report their opinion that the prayer of such petition ought to be complied with, whereupon his Majesty may, if he think fit, grant such prayer; but any person opposing such petition shall be entitled to be heard before the said judicial committee; and any person, party to any former suit touching such first letters patent, shall have notice of such petition.

3. If, in any action or suit, a verdict or decree shall pass for the patentee, the judge may grant a certificate, which being given in evidence in any other suit, shall entitle the patentee, upon a verdict in his favor, to receive treble costs.

4. Allows a patentee, on advertising as therein mentioned, to apply to the privy council for a prolonged term. If the judicial committee report in his favor, his term may be prolonged for seven years; but such application must be made before the expiration of the original term.

5. In case of action, &c., notice of objections to be given with the pleadings.

6. Costs in actions for infringing letters patent, to be given as either party has succeeded or failed in any part of his case, without regard to the general result of the trial.

7. Penalty for using, unauthorized, the name or device of a patentee, &c., £50, one half to his Majesty, and the other to any informer.

Mr. Farey, who has had much experience in superintending the taking of patents, states, that the average expense of a patent for England, may be estimated at £120; for Scotland, at £100; and for Ireland, £125.

COINS AND MEDALS.

In a lecture lately delivered before the Society of Arts, Mr. Wyon described our present mode of engraving and multiplying the dies.

The selection of the best steel for the purpose, he observed, was very important, and not sufficiently understood at present. The very fine steel that forms excellent gravers and other cutting instruments, is unfit for the purpose, for unless hardened with great care, it is very liable to crack. The very coarse steel is also objectionable, as it acquires fissures under the die press. The object therefore is, to select steel of a medium quality—but the best steel may be spoiled, by want of skill in the smith who forges the dies.

When the rough die is brought to a table in the turning lathe, after being softened, the engraver commences his labors, by working out the device with the small tools in intaglio (sunk in), and when he has completed his work, the die is ready for hardening, which is, in itself, a very simple process—but one that is often attended with serious disappointment to the engraver, for it not unfrequently happens, that the labor of many months is either injured or utterly destroyed, from the steel itself being faulty or heated to excess. But supposing the original die, or, as it is technically called, a matrix, to be uninjured by the process of hardening, it is reserved for the purpose of furnishing a puncheon (or a steel impression in relief). For this purpose, a block of soft steel is turned flat at the bottom and obtusely conical at the top. In this state, its conical surface is compresed into the matrix by a blow from the multiplying die press: this gives us only the commencement of an impression, for the die becomes so hard by compression, as to require frequent annealing and re-striking before it is perfected. An impression taken in this way is called a puncheon, which, when the engraver has given to it all the delicacy of finish existing in the original, is then hardened, and serves for the purpose of making dies for coining, by a similar process, viz., impressing the hardened steel into that which is soft.

The distinction, said Mr. Wyon, between striking medals and coins, is very essential, so much so, that I cannot avoid saying a few words on the subject. A medal is usually engraved in high relief, like those upon ancient coins, and it requires a succession of blows, sometimes forty or fifty, with repeated annealings, to make a perfect impression. A modern coin, on the contrary, is usually brought up with one blow, although with the disadvantage of the metal being harder. Standard gold, for instance, consists of one-twelfth of alloy: medals are usually made of fine gold; the engraving upon the coin is consequently made with a suitable degree of relief.

In striking a coin or medal, the lateral spread of the metal, which would otherwise ooze out, as it were, from between the dies, is prevented by the application of a steel collar, accurately turned to the dimensions of the dies. The number of pieces which may be struck by one pair of dies, not unfrequently amounts to between three and four hundred thousand, but the average amount is much less. Mr. Wyon stated, that he remembered instances of twenty dies being destroyed in one day, owing to the different qualities of steel, and to the casualties to which dies are liable. There are, it appears, eight presses in the coining-room of the Mint, and he considers that the destruction of one pair of dies for each press per day, is a very fair proportion, though it is generally rather more.

It must be remembered, that each press produces sixty pieces per minute, without reckoning stoppages occasioned by changing of dies and other contingences; and Mr. Wyon remarked, that in 1817, the daily produce of coins, in half-crowns, shillings, and sixpences, amounted to the enormous quantity of 343,000 per day for three months: at that time all the eight presses were employed; but, on the 1st of April, 1832, there were 125,000 pieces coined with five presses only. From the 4th of June, 1817, to the 31st of December, 1833, there were coined in sovereigns and half sovereigns, 52,187,265*l.* sterling.

CAUTION TO EXPERIMENTERS WITH THE ELECTRIC KITE.

The following excellent remarks on the management of the electric kite are by the well-known and excellent electrician, Mr. Sturgeon, who, perhaps, has had more practical experience in electrical manipulation than any person living. The remarks also on the electric kite by the Editor in the early part of Vol. I. of this Magazine will be read by the tyro with interest. Mr. Sturgeon says:—

"I repaired to the Artillery Barrack grounds with an electric kite, and in a very short time got it afloat, letting out string through the hands from a coil or clue which was thrown on the ground. When about a hundred yards of the string had been let out, a tremendous discharge took place, which gave me such a blow in the chest and legs that I became completely stunned, let go the string, and consequently the kite soon fell.

The accident was owing entirely to my own neglect, and could not possibly have happened had I taken the following precaution:—

Let all the string intended to be employed be first taken off the reel or coil, and stretched on the ground. Let now the insulating cord, ribbon, glass, or whatever is used for this purpose, be attached to the kite-string and fastened to a peg, tree, or anything intended to hold the kite during the time it is up. Next fasten the kite to the other end of the string, and let it ascend from the hand.

This is the manner in which I usually proceed when heavy clouds are hovering about, and ought always to be attended to, although I neglected it on on this occasion. The experimenter by this means is completely out of danger; and he may easily ascertain if the string be highly charged by going to the other end, because of the brushes of light, and noise attending them.

I find it convenient to have a sliding copper wire on the silken cord, which can be moved, by means of a long glass rod, to any required distance from the wired string, the other end being stuck fast in the ground. If the electric fire strikes two inches over the dry silken sord, (and it will sometimes strike a yard,) it would not be safe to approach it; and no man could hold the string when it strikes over one inch of the silk, or, which is the same thing, through the air.

After the electrical state of the string has been ascertained, the wire may be slided away from it as far as possible (the silk ought never to be less than two yards long). The other end is then to be taken out of the ground and attached to the apparatus for experiment. The wire is again slided up to the wired string, and left there during the time the experiments are carrying on.

The only method of getting the kite down during an intense electrization of the string, with safety to the experimenter, is to unfasten the silken cord from its hold and let all go: the kite falls. I have frequently been annoyed, whilst holding the kite-string during hot hazy days when no cloud was visible, by a rapid succession of discharges, from which I had no other means of escape than by quitting the string and letting the kite fall. The same thing sometimes happens in cold dense fogs in the winter. I have experienced these rattling or tremulous shocks when the kite has not been more than 30 yards from the ground, and the wired string at the same time touching it. Hence great quantities of the fluid must necessarily pass into the ground directly through the wire, in addition to that which produced the shocks.

The publication of these particulars may possibly prevent some inexperienced electrician from receiving a death-blow from his kite-string.

Young persons who are fond of kite-flying should also be cautious not to have their kites up during thunder storms, as it is possible that a wet string may transmit a violent discharge, from which a serious accident might occur."

MAKING ARTIFICIAL EYES FOR ANIMALS.

MUCH of the character and expression of animals depends upon their eyes: it will, therefore, be evident that great attention is necessary in the artificial imitation of these.

The instruments necessary for making these are enameller's table, bellows, lamp, round pincers about six inches in length, which are closed by means of a ring, and with which is held the iron-wire forming the support, and the base of these eyes, which it is impossible to blow. Procure another flat pair of pincers of the same length, which are used for handling the enamel, as also for stirring up the lamp. These instruments can be had ready made in every hardware shop.

The materials from which the eyes themselves are formed is an assortment of cylinders of enamel of all colors, which can be purchased; besides some fragments or clippings of mirror-glass, which are melted in the lamp into a kind of cylinder like the enamel, so that they may be ready for use when required. During the process of melting these pieces of glass, considerable attention is necessary to free them from spots and globules of air. These cylinders can be procured ready made in the shops; and at various glass-manufactories.

The table is placed in a situation where the light of day cannot reach it, as the double light would distract the vision during the operation.

After the lamp has been lighted, the pipe of the bellows is directed towards the middle of the wick, which is slightly scattered in that part so as to procure a clear light-bluish flame, which is necessary to secure success in the operation, because if it is not clear, the colors of the enamel are liable to change during the operation of making the eyes. The enamel which we wish to melt should be applied to the extremity of the jet of the flame, which it will not burn, and often melts more easily than in the centre.

As small eyes are less difficult than large ones, it will be advisable to commence with them until we shall have acquired practice. For small eyes, a small iron-wire is used about an inch and a half long, one end of which is held in the round pincers, and the other is approached to the fire, to which is exposed at the same time the enamel of the color we wish the eye, whilst the other is turned beween the fingers until it begins to melt. The quantity necessary for the size of the eye is then fastened to the end of the iron-wire. This by being turned in the flame forms a small globe, and when it is sufficiently rounded, a little speck of black enamel is placed in the centre, for the purpose of imitating the pupil. It is again exposed to the flame that the pupil may be blended into the mass. When it is properly incrusted, some glass is put upon it, which should extend three quarters across the hemisphere of the eye. This glass is intended to represent the vitreous humour of the eye, and from which all its brilliancy proceeds. The eye is still exposed to the flame until the glass has extended over that part of the eye which is intended for the iris; when we effect this, it is allowed to cool slowly. This kind of eye is made by joining several pieces of iron-wire together, which renders it easier to make them all uniform in point of size, because the first being close to our eyes guides us in the formation of the others.

Second Method of Making Eyes.—Another method of making eyes is the following:—Some pieces of iron-wire, from three to four inches long, are prepared, which have been well burned. Their strength must be proportioned to the size of the eye which is intended to be made. These are curved in the middle over a tube of glass enamel, or any other cylindrical and polished body: the extremities of each wire are united by twisting one over the other, so that they perfectly fit the substance which they embrace. It is this circle formed by the wire which makes the diameter of the eye, and the wire thus prepared is in the form of a rocket. The handle of this rocket is fixed into the round pincers, and the head of it curved by making it parallel to that of the pincers. This circle is filled with common enamel, of the color which we wish, extending it from the circumference to the centre, and when it is nearly the thickness of the wire, it is pressed while yet in a state of fusion with the flat pincers, so that it may extend equally over the entire circumference. It is then put into the fire to consolidate it. This having been done, the iris is formed by a drop of enamel of the proper color. This is heated and pressed as before with the flat pincers, and when it is incorporated with the first enamel, the pupil is represented with a small speck of black enamel, as before mentioned. When this is melted and incrusted in the iris, both are covered with glass, and heated again until all the parts are smooth, and the glass has diffused itself over the whole iris. The eye is now placed on some warm cinders, and left to cool slowly, without which precaution it is liable to break; or it may be put into warm water, and allowed to cool gradually. It is then removed from the wire by loosening the latter. This method is only adapted for eyes of a middling size.

Third Method of Making Eyes.—There is still another method of making eyes, which is perhaps better than those we have already described; and that is, to blow them if we possibly can; which, however, cannot be done when they are small. In this operation, a pipe of baked earth is used, or a tube of glass six or seven inches in length, at the end of which a little white enamel is placed. This is placed to the flame, so that it may be blown. This forms a globe, whose dimensions depend upon the quantity of air introduced. When this globe is of the size wished, we place in the middle, and perpendicularly to the point of the pipe, the quantity of enamel necessary to form the enamel. The second enamel is then incorporated with the first, by presenting it to the flame, while attention is paid to turn the pipe gradually round, so that the enamel may diffuse itself equally, and the iris be exactly circular. If it is required that this iris should be of various colors, like that of man for example, small filaments of enamel are distributed in diverging rays of the suitable color; the eye is then placed in the flame, until these have incorporated with the iris, after which the pupil is placed as before directed.

During this operation, the globe is almost certain of sinking down, partly from the air escaping, partly from the heat, and from the pressure which is used in applying the different substances: air must again be supplied from time to time to prevent it from losing its form. This becomes particularly necessary when glass is applied, and when it is extended over the whole surface of the iris.

The eye having got its form and size, the pipe is taken away. To effect this, after the air has been introduced, the entrance of the pipe is stopped with the finger, and the back part of the eye exposed to the flame; when the air contained in the globe and rarefied by the pipe, comes through at the place where the flame has most action. This opening is prolonged by turning the point of the flat pincers, or an iron-wire, all round the pipe; one point only is left by which the eye remains fixed. It is then warmed equally all over, after which it is exposed to a gentle heat, and when it again cools, it is separated from the pipe.

PALINGENESY.

(*From Ozanam's Mathematical Recreations.*)

PALINGENESY is a chemical operation, by means of which, a plant, or an animal, as some pretend, can be revived from its ashes. This, if true, would no doubt be one of the noblest secrets of chemistry and philosophy. If some authors are to be credited, several learned men of the 17th century were in possession of it; but at present, as this pretended secret, in consequence of the great progress made in chemistry, is considered as a mere chimera, we shall here confine ourselves to examining the foundation of those principles which have induced some respectable authors, such as the Abbé Vallemont and others, to believe in the possibility of this process.

According to the honest Abbé, nothing is simpler and easier to be explained. We are indeed told, says he, by Father Kircher, that the seminal virtue of each mixture is contained in its salts, and these salts unalterable by their nature, when put in motion by heat rise in the vessel through the liquor in which they are diffused. Being then at liberty to arrange themselves at pleasure, they place themselves in that order in which they would be placed by the effect of vegetation, or the same as they occupied before the body, to which they belonged, had been decomposed by the fire: in short, they form a plant, or a phantom of a plant, which has a perfect resemblance to the one destroyed.

This reasoning is worthy of an author who could believe that he who robs another of his money can exhale corpuscles different from those exhaled by a man who carries his own, and thereby make the divining rod turn towards the places where he has passed, or remained for some time. Does it not show great weakness to believe that the mere immorality of an action can produce physical effects? It would indeed be offering an insult to our readers, to attempt to show the folly and absurdity of the above reasoning of the good Abbé, and of Father Kircher. Let us therefore only examine the facts which he relates.

An English chemist, named Coxe, asserts that having extracted and dissolved the essential salts of fern, and then filtered the liquor, he observed, after leaving it at rest for five or six weeks, a vegetation of small ferns adhering to the bottom of the vessel. The same chemist, having mixed northern potash with an equal quantity of sal ammoniac, saw some time after a small forest of pines, and other trees, with which he was not acquainted, rising from the bottom of the vessel.

The following fact is considered by the author as more conclusive. The celebrated Boyle, though not very favorable to palingenesy, relates, that having dissolved in water some verdigris, which, as is well known, is produced by combining copper with the acid of vinegar, and having caused this water to congeal by means of artificial cold, he observed at the surface of the ice small figures, which had an exact resemblance to vines.

Notwithstanding these facts, and others quoted by the Abbé from Daniel Major, Hanneman, and various authors, if the partisan of palingenesy can produce none more conclusive, it must be confessed that they support their assertions by very weak proofs. Every true chemist sees in these phenomena nothing but a simple ramified crystallization, which may be produced by different well known compositions: the most beautiful of these crystallizations, call improperly vegetations, are produced by the combination of bodies from the animal kingdom.

The last experiment, related by Boyle, might occasion more embarrassment; but as it is the only one, of a great many, made with the essential salts of a variety of plants, that succeeded, there can be no doubt that the figures he saw were the mere effect of chance; for how many other philosophers, who made the same attempt, saw nothing but what is exhibited by the surface of frozen water, which sometimes forms ramifications exceedingly complex?

The partisans of palingenesy however quote other authorities, to which they attach great importance. We are told by Sir Kenelm Digby, on the authority of Quercetan, physician to Henry IV. of France, that a Pole showed twelve glass vessels hermetically sealed, each containing the salts of different plants: that at first these salts had the appearance of ashes, but that when exposed to a gentle and moderate heat, the figure of the plant, as a rose for example, if the vessel contained the ashes of a rose, was observed gradually to rise up, and that as the vessel cooled the whole disappeared. Sir Kenelm adds, that Father Kircher had assured him, that he performed the same experiment, and that he communicated to him the secret, but it never had succeeded. The story of this Pole is related by various other authors, such as Bary, in his Physique, and Guy de la Brosse, in his book on the Nature of Plants.

(*To be continued*)

MISCELLANEOUS EXPERIMENTS.

The Three Haloes.—The following experiment, which illustrates in a pleasing manner the actual formation of haloes, has been given by Dr. Brewster:—Take a saturated solution of alum, and having spread a few drops of it over a plate of glass, it will rapidly crystallise in small flat octohedrons, scarcely visible to the eye. When this plate is held between the observer and the sun, or a candle, with the eye very close to the smooth side of the glass plate, there will be seen three beautiful haloes of light, at different distances from the luminous body. The innermost halo, which is the whitest, is formed by the images refracted by a pair of faces of the octohedral crystals, not much inclined to each other; the second halo, which is more colored, with the blue rays outwards, is formed by a pair of faces more inclined; and the third halo, which is very large and highly colored, is formed by a still more inclined pair of faces. Each separate crystal forms three images of the luminous body, placed at points 120° distant from each other, in all the three haloes; and as the numerous small crystals have their refracting faces turned in every possible direction, the whole circumference of the haloes will be completely filled up. The same effects may be obtained with other crystals; and when they have the property of double refraction, each halo will be either doubled, when the double refraction is considerable, or rendered broader, and otherwise modified in point of color, when the double refraction is small. The effects may be curiously varied, by crystallising upon the same plate of glass, crystals of a decided color, by which means we should have white and colored haloes succeeding each other.

To obtain very large Ornamental Crystals.—To obtain large artificial crystals of a regular shape, requires considerable address, and much patient attention; but the result fully recompenses the trouble. The method of M. Leblanc is as follows:—The salt to be crystallised is to be dissolved in water, and evaporated to such a consistency that it shall crystallise on cooling. Set it by, and when quite cold, pour the liquid part off the mass of crystals at the bottom, and put it into a flat-bottomed vessel. Solitary crystals form at some distance from each other, and these may be observed gradually increasing. Pick out the most regular of these, put them into a flat-bottomed vessel at some distance from each other, and pour over them a quantity of liquid obtained in the same way, by evaporating a solution of the salt, till it crystallises on cooling. Alter the position of every crystal, once at least every day, with a glass rod, that all the faces may be alternately exposed to the action of the liquid; for the face on which the crystal rests never receives any increase. By this process, the crystals gradually increase in size. When they have acquired such a magnitude that their forms can easily be distinguished, the most regular are to be chosen, or those which have the exact shape which we wish to obtain; and each of them is to be put separately into a vessel filled with a portion of the same liquid, and turned in the same manner several times a day. By this treatment, they may be obtained of almost any size we think proper. Whenever it is observed that the angles and edges of the crystal become blunted, the liquid must immediately be poured off, and a portion of new liquid put in its place; otherwise the crystal is infallibly destroyed.

To Bleach Prints and Printed Books.—Simple immersion in oxygenated muriatic acid, letting the article remain in it, a longer or shorter space of time, according to the strength of the liquor, will be sufficient to whiten an engraving: if it be required to whiten the paper of a bound book, as it is necessary that all the leaves should be moistened by the acid, care must be taken to open the book well, and to make the boards rest on the edge of the vessel, in such a manner that the paper alone shall be dipped in the liquid; the leaves must be separated from each other, in order that they may be equally moistened on both sides. The liquor assumes a yellow tint, and the paper becomes white in the same proportion; at the end of two or three hours, the book may be taken from the acid liquor, and plunged into pure water with the same care and precaution as recommended in regard to the acid liquor, that the water may touch both sides of each leaf. The water must be renewed every hour, to extract the acid remaining in the paper, and to dissipate the disagreeable smell.

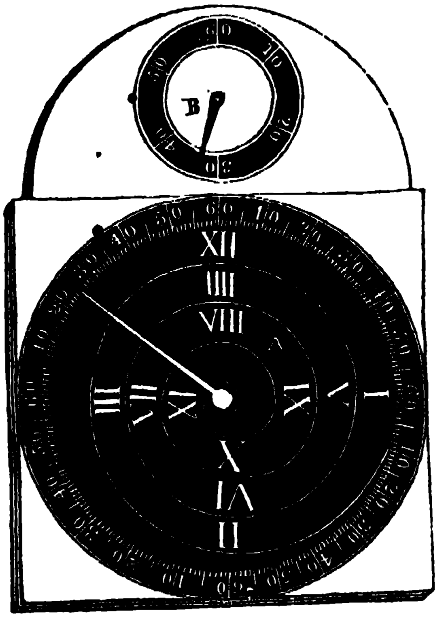
Beautiful Ornament for a Room.—Dissolve in seven different tumblers, containing warm water, half ounces of sulphates of iron, copper, zinc, soda, alumine, magnesia, and potass. Pour them all, when completely dissolved, into a large evaporating dish of Wedgwood's ware, and stir the whole with a glass rod; place the dish in a warm place, where it cannot be affected by dust; or where it may not be agitated. When the evaporation has taken place, the whole will begin to shoot out into crystals. These will be interspersed in small groups, and single crystals amongst each other. Their color and peculiar form of crystalization, will distinguish each crystal separately, and the whole together, remaining in the respective places where they were deposited, will display a very curious and pleasing appearance. Preserve it carefully from dust.

The Exploding Bubble.—If you take up a small quantity of melted glass with a tube (the bowl of a common tobacco pipe will do), and let a drop fall into a vessel of water, it will chill and condense with a fine spiral tail, which being broken, the whole substance will burst with a loud explosion, without injury either to the party that holds it, or him that breaks it; but if the *thick* end is struck, even with a hammer, it will not break.

Three Objects, discernable only by the use of both Eyes.—If you fix three pieces of paper against the wall of a room, at equal distances, at the height of your eye, placing yourself directly before them, at a few yards distance, and close your right eye, and look at them with your left, you will see only two of them, suppose the first and second; alter the position of your eye, and you will see the first and third; alter your position a second time, you will see the second and third, but never the whole three together; by which it appears, that a person who has only one eye can never see three objects placed in this position, nor all the parts of one object of the same extent, without altering the situation of his eye.

Two solid Metallic Alloys, which melt, when rubbed together.—Make an amalgam of bismuth, and an amalgam of lead, rub them together in a mortar, they will form a compound which is nearly as liquid as mercury.

Fig. 1.



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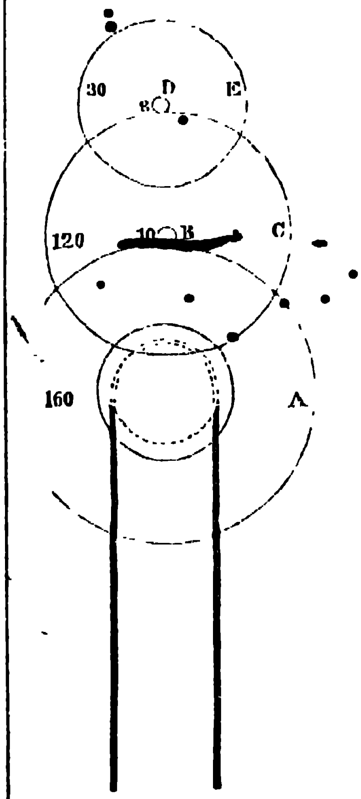

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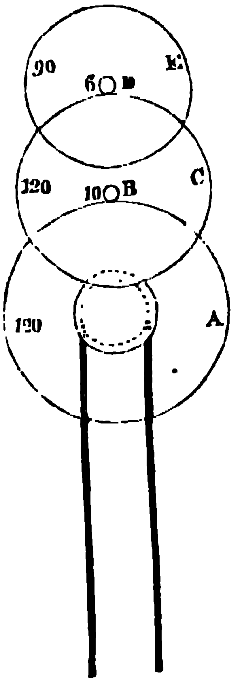

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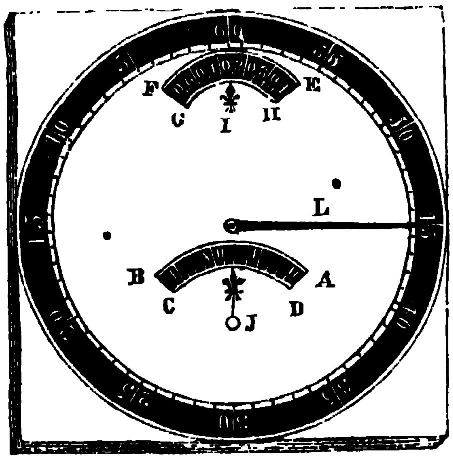

FRANKLIN'S AND FERGUSON'S CLOCKS.

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An ingenious clock was contrived by the late Dr. Franklin, of Philadelphia, that showed the hours, minutes, and seconds, with only three wheels and two pinions in the whole movement. A description of which, we think, will please such of our readers as are not acquainted with it, which we believe are very few.

The dial-plate of this clock is represented by Fig. 1. The hours are engraved in spiral places, along two diameters of a circle, containing four times 60 minutes. The index A goes round in four hours, and counts the minutes from any hour it has passed by to the next following hours. The time as appears in the figure is either 24 minutes past 3, or past 7, or past 11; and so on in each quarter of the circle, pointing to the number of minutes after the hours the index last left in its motion. Now, as one can hardly be four hours mistaken in estimating the time, he can always tell the true hour and minute by looking at the clock, from the time he rises till the time he goes to bed. The small hand B, in the arch at top, goes round once in a minute, and shows the seconds as in a common clock.

Fig. 2 shows the wheel-work of the clock. A is the first or great wheel; it contains 160 teeth, goes round in four hours, and the index A (Fig. 1) is put upon its axis, and moved round in the same time. The hole in the index is round; it is put tight upon the round end of the axis, so as to be carried by the motion of the wheel, but may be set at any time to the proper hour and minute, without affecting either the wheel or its axis. This wheel of 160 teeth turns a pinion, B, of ten leaves; and as 10 is but a sixteenth part of 160, the pinion goes round in a quarter of an hour. On the axis of this pinion is the wheel C of 120 teeth; it also goes round in a minute; for there are 15 minutes in a quarter of an hour, and 8 times 15 is 120. On the axis of this pinion is the second hand B, (Fig. 1) and also the common wheel E, (Fig. 2) of 30 teeth, for moving a pendulum (by pallets) that vibrates seconds, as in a common clock.

This clock is not designed to be wound up by a winch, but to be drawn up like a clock that goes only thirty hours. For this purpose, the line must go over a pulley on the axis of the great wheel, as in a common thirty-hour clock.

One inconvenience attending this clock is, that if a person wake in the night, and look at the clock, he may possibly be mistaken in the four hours, in reckoning the time by it, as the hand cannot be upon any hour, or pass by any hour, without being upon, or passing by, four hours at the same time. In order, therefore, to avoid this inconvenience, the ingenious Mr. Ferguson contrived the following method.

In Fig. 3, the dial-plate of such a clock is represented; in which there is an opening A B C D, below the centre. Through this opening, part of a flat plate appears, on which the 12 hours are engraved, and divided into quarters. This plate is contiguous to the back of the dial-plate, and turns round in 12 hours; so that the true hour or part thereof, appears in the middle of the opening, at the point of an index, F, which is engraved on the face of the dial-plate. G is the minute-hand as in a common clock, going round through all the 60 minutes on the dial in an hour; and in that time, the plate seen through the opening A B C D shifts one hour under the fixed, engraven index E. By these means the hour and minute may be always known at whatever time the dial-plate is viewed. In this plate is another opening, E F G H, through which the seconds are seen on a flat moveable ring, almost contiguous to the back of the dial-plate, and as the ring turns round, the seconds upon it are shown by the top point of a fleur-de-lis I, engraved on the face of the dial-plate.

Fig. 4 represents the wheels and pinions in this clock. A is the first or great wheel; it contains 120 teeth, and turns round in 12 hours. On its axis is the plate on which the 12 hours above-mentioned are engraved. This plate is not fixed on the axis, but is only put tight upon a round part thereof, so that any hour, or part of an hour, may be set to the top of the fixed index A, (Fig. 3.) without affecting the motion of the wheel. For this purpose, twelve small holes are drilled through the plate, one at each hour, among the quarter divisions: and by putting a pin into any hole in view, the plate may be set, without affecting any part of the wheel-work. This great wheel A, of 120 teeth, turns a pinion B, of ten leaves, round in an hour; and the minute-hand L, Fig. 3, is on the axis of this pinion, the end of the axis not being square but round, that the minute-hand may be turned occasionally upon it without affecting any part of the movement. On the axis of the pinion B is a wheel C of 120 teeth, turning round in an hour, and turning a pinion D, of six leaves, in three minutes; for three minutes is a twentieth part of an hour, and six is a twentieth part of 120. On the axis of this pinion is a wheel E of 90 teeth, going round in three minutes, and keeping a pendulum in motion that vibrates seconds, by pallets, as in a common clock, where the pendulum-wheel has only 30 teeth, and goes round in a minute. But as this wheel goes round only in three minutes, if it be wanted to show the seconds, a thin plate must be divided into 3 times 60, or 180 equal parts, and numbered 10, 20, 30, 40, 50, 60; 10, 20, 30, 40, 50, 60; 10, 20, 30, 40, 50, 60; and fixed upon the same axis with the wheel of 90 teeth, so near the back of the dial-plate, as only to turn round without touching it: and these divisions will show the seconds through the opening E F G H in the dial-plate, as they slide gradually round below the point of the fixed fleur-de-lis I.

As the great wheel A, and pulley on its axis, over which the cord goes, (as in a common thirty-hour clock,) turns round only once in twenty-four hours, this clock will go a week with a cord of common length, and always have the true hour, or part of that hour, in sight at the upper end of the fixed index A on the dial-plate.

There are two advantages which Mr. Ferguson's clock has beyond Dr. Franklin's: but it has two disadvantages of which his clock is free. For in this, although the twelve-hour-wheel turns the minute index L, yet if that index be turned by hand to set it to the proper minute for any time, it will not move the twelve-hour plate to set the corresponding part of the hour even with the top of the index J: and, therefore, after having set the minute index L right by hand, the hour-plate must be set right by means of a pin put into the small hole in the plate just below the hour. It is true there is no great disadvantage in this; but the pendulum-wheel having ninety teeth instead of the common number thirty, may probably make some difference to the scapement, on account of the smallness of the teeth; and it is certain that it will cause the pendulum-ball to describe but small arcs in its vibrations. Some men of science think small arcs are best; but wherefore we know not. For whether the ball describes a large or small arc, if the arc be nearly cycloidal, the vibrations will be performed in equal times; the time therefore will depend entirely on the length of the pendulum-rod, not on the length of the arc the ball describes. The larger the arc is, the greater the momentum of the ball; and the greater the momentum is, the less will the time of the vibrations be affected by any unequal impulse of the pendulum-wheel upon the pallets.

The greatest objection to Mr. Ferguson's clock is, that the weight of the flat ring on which the seconds are engraved, will load the pivots of the axis of the pendulum-wheel with a great deal of friction, which ought by all possible means to be avoided; and yet one of these clocks, recently made, goes very well, notwithstanding the weight of this ring. This objection, however, can easily be remedied by leaving it out; for seconds are of very little use in common clocks not made for astronomical observations; and table clocks never have them.

CARTHAMUS.

Carthamus, or safflower *(carthamus tinctorius)*, the flower of which alone is used in dyeing, is an annual plant cultivated in Spain, Egypt, and the Levant. There are two varieties of it—one which has large leaves, and the other smaller ones. It is the last which is cultivated in Egypt, where it forms a considerable article of commerce.

Carthamus contains two coloring matters, one yellow and the other red. The first alone is soluble in water; its solution is always turbid: with reagents it exhibits the characters usually remarked in yellow coloring matters. The acids render it lighter, the alkalies deepen it, giving it more of an orange hue: both produce a little dun precipitate, in consequence of which it becomes clearer. Alum forms a precipitate of a deep yellow, in small quantity. The solution of tin and the other metallic solutions cause precipitates which have nothing remarkable in them.

The yellow matter of carthamus is not employed; but in order to extract this portion, the carthamus is put into a bag, which is trodden under water, till no more color can be pressed out. The flowers, which were yellow, become reddish, and lose in this operation nearly one half of their weight. In this state they are used.

For extracting the red part of carthamus, and thereafter applying it to stuff, the property which alkalies possess of dissolving it is had recourse to, and it is afterwards precipitated by an acid.

The process of dyeing consists, therefore, in extracting the coloring matter by means of an alkali, and precipitating it on the stuff by means of an acid. It is this fecula which serves for making the rouge employed by ladies.

As to this rouge, the solution of carthamus is prepared with crystallised carbonate of soda, and it is precipitated by lemon juice. It has been remarked that lemons, beginning to spoil, were fitter for this operation than those which were less ripe, whose juice retained much mucilage. After squeezing out the lemon juice, it is left to settle for some days. The precipitate of carthamus is dried at a gentle heat upon plates of stone-ware; from which it is detached and very carefully ground with talc, which has been reduced to a very subtile powder, by means of the leaves of shave-grass *(equisetum)*, and successively passed through sieves of increasing fineness. It is the fineness of the talc, and the greater or less proportion which it bears to the carthamus precipitate, which constitute the difference between the high and low priced rouges.

Carthamus is used for dyeing silk, poppy, *nacarat* (a bright orange-red), cherry, rose color, and flesh color. The process differs according to the intensity of the color, and the greater or less tendency to flame color that is wanted. But the carthamus bath, whose application may be varied, is prepared as follows:—

The carthamus, from which the yellow matter has been extracted, and whose lumps have been broken down, is put into a trough. It is repeatedly sprinkled with cendres gravelées (crude pearl ashes), or soda (barilla) well powdered and sifted at the rate of 6 pounds for 120 pounds of carthamus; but soda is preferred, mixing carefully as the alkali is introduced. This operation is called *amestrer.*—The *amestred* carthamus is put into a small trough with a grated bottom, first lining this trough with a closely woven cloth. When it is about half filled, it is placed over the large trough, and cold water is poured into the upper one, till the lower becomes full. The carthamus is then set over another trough, till the water comes from it almost colorless. A little more alkali is now mixed with it, and fresh water is passed through it. These operations are repeated till the carthamus is exhausted, when it turns yellow.

After distributing the silk in hanks upon the rods, lemon juice, brought in casks from Provence, is poured into the bath till it becomes of a fine cherry color; this is called turning the bath *(virer le bain)*. It is well stirred, and the silk is immersed and turned round the skein-sticks in the bath, as long as it is perceived to take up the color. For *ponceau* (poppy color), it is withdrawn, the liquor is run out of it upon the peg, and it is turned through a new bath, where it is treated as in the first. After this it is dried and passed through fresh baths, continuing to wash and dry it between each operation, till it has acquired the depth of color that is desired. When it has reached the proper point, a brightening is given it by turning it round the sticks seven or eight times in a bath of hot water, to which about half a pint of lemon juice for each pailful of water has been added.

When silk is to be dyed *ponceau* or poppy color, it must be previously boiled as for white; it must then receive a slight foundation of annotto, as explained in treating of this substance. The silk should not be alumed.

The *nacarats*, and the deep cherry colors, are given precisely like the *ponceaux*, only they receive no annotto ground; and baths may be employed which have served for the *ponceau*, so as to complete their exhaustion. Fresh baths are not made for the latter colors, unless there be no occasion for the poppy.

With regard to the lighter cherry-reds, rose color of all shades of flesh colors, they are made with the second and last runnings of the carthamus, which are weaker. The deepest shades are passed through first.

The lightest of all these shades, which is an extremely delicate flesh color, requires a little soap to be put into the bath. This soap lightens the color, and prevents it from taking too speedily, and becoming uneven. The silk is then washed, and a little brightening is given it, in a bath which has served for the deeper colors.

All these baths are employed the moment they are made, or as speedily as possible, because they lose much of their color upon keeping, by which they are even entirely destroyed at the end of a certain time. They are, moreover, used cold, to prevent the color from being injured. It must have been remarked in the experiments just described, that the caustic alkalies attack the extremely delicate color of carthamus, making it pass to yellow. This is the reason why crystals of soda are preferred to the alkaline matters.

In order to diminish the expense of the carthamus, it is the practice in preparing the deeper shades to mingle with the first and the second bath about one-fifth of the bath of archil.

Dobereiner regards the red coloring matter of carthamus as an acid, and the yellow as a base.—His carthamic acid forms, with the alkalies, colorless salts, decomposed by the tartaric and acetic acids, which precipitate the acid of a bright rose-red. Heat has a remarkable influence upon carthamus, rendering its red color yellow and dull.—Hence, the colder the water is by which it is extracted, the finer is the color. Light destroys the color very rapidly, and hitherto no means have been found of counteracting this effect. For this reason this brilliant color must be dried in the shade, its dye must be given in a shady place, and the silk stuffs dyed with it must be preserved as much as possible from the light. Age is nearly as injurious as light, especially upon the dye in a damp state.—The color is very dear, because a thousand parts of carthamus contain only five of it.

In preparing the finest rouge, the yellow coloring matter being separated by washing with water, the red is then dissolved by the aid of alkali, and is thrown down on linen or cotton rags, by saturating the solution with vegetable acid. The color is rinsed out of these rags, dissolved anew in alkalis, and once more precipitated by lemon juice. The best and freshest carthamus must be selected. It is put into linen bags, which are placed in a stream of water, and kneaded till the water runs off colorless. The bags are then put into water, soured with a little vinegar, kneaded till the color is all expelled, and finally rinsed in running water. By this treatment the carthamus loses nearly half its weight.—6633 cwts. of safflower were imported into the United Kingdom in 1835, of which 2930 cwts. were retained for internal consumption.

ENGRAVING.

Engraving is understood to be the art of cutting the surface of wood, or smooth metal, so that the lines formed may be covered or filled up with ink; then being subjected to an appropriate pressure, the ink shall be left on the surface of the paper printed upon, forming what is called an etching, a wood, copper, or steel engraving, according to the material worked upon, or else the manner in which the work is executed. In the latter sense, engraving is primarily divided into three great sections, each totally distinct from the other.

Engraving on wood, or wood engraving, in which lines are left even with the surface, the rest of the wood being cut away; these are printed at the common printing press, alone or attended with type, such as illustrate this and other similar works.*

To describe the *manner* of etching and copper-plate engraving, in general terms, so that it may be understood without entering into minute particulars, it may be said to be performed thus:—First, the copper or other plate is covered evenly and thinly with a certain composition, called *etching ground*. The design or drawing is then transferred to it; then in the case of etching, the lines thus seen on the ground, are scratched with an etching needle, so as to lay bare the surface of the copper beneath the ground: then, a waxy substance is made to adhere to the plate, so as to form a border around the picture, as it may be called, about half an inch high; the plate has then an acid poured upon it, which eats or corrodes away the exposed lines of copper. When sufficiently corroded, the bordering wax is taken away, and the plate washed with spirits of turpentine, which removes the etching ground, and shows the copper-plate, bright as when first taken in hand, but with at least an outline, and in most instances a drawing considerably shaded. It will be remarked that no tool whatever has been as yet used, except a needle. This then, constitutes an *etching*, which is merely a plate of metal with lines corroded in it by means of an acid. Those etchings which are afterwards to be made into engravings, are *bit in* very faintly, but the lines are afterwards cut deeper or wider, by a small tool, called a *graver*, or *burin*.

Etchings and engravings, having lines, or, in some cases, dots *below* the general surface, the printing is conducted as follows:—The whole plate is covered with ink, and the surface then cleaned, leaving only the ink in the lines; passing this through the copper-plate printer's rolling press, with a tight pressure, the paper adheres to and brings the ink out of the lines, forming what is called a *proof*, if of the best quality, and a *print*, if of secondary value. The illustrative figures in the present No. will give an idea of the difference between engraving on wood and on metallic plates, although in this instance both are executed on wood. The side-cuts, and also a part of the others, consist of lines *left*, the rest of the wood being cut away; but in the clock faces, the general surface is left untouched, and the lines only are cut away. The surface of these is blackened with ink and printed, but in copper-plate printing, the letters, figures, and marks only would appear: thus, our leading cuts represent the engraved plate or etching, and not a print taken from that plate.

This being clearly understood, the next things to be considered are the requisite tools and materials, and we would premise that the same are used for every style of metallic engraving, modified only in a trifling degree to suit the material to be engraved, or perhaps one or other of them may not be wanted, except in particular circumstances.

The only tools required, are a *hand vice*, a *sand cushion*, two or three *gravers* of different sizes, an *etching needle*, a *burnisher*, a *scraper*, a *rule*, with a straight edge, two *fitch pencils*, or *brushes*, (one as small as possible, the other about as large as a small goose-quill,) a *dabber*, an *oil rubber*, and a piece of *Turkey stone*; and if mathematical or similar engravings are to be executed, a case of the usual drawing instruments must be added. The materials required, are *sheets of copper or steel*, to engrave upon, *etching ground*, *bordering wax*, *nitric acid*, *Brunswick black varnish*, *spirits of turpentine*, a *wax taper*, some *oil*, and a fine piece of clear *charcoal*, with the bark scraped off, and one end made smooth.

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* A full account of the art of Engraving in Wood, is given in Vol. I. containing a description of the various tools, &c. We therefore do not intend further to allude to that particular art but confine ourselves at present to engraving on metal.

The *sand cushion* is a flat leather bag, made in the first instance like the two sides of a leather cricket ball. It is formed of sheep leather, and when the sides are sewed together, leaving but a small hole in the sewing, it is filled with sand; the sewing is then completed—the whole soaked for a day in water, and then pressed with a great weight, or in a screw press, when it assumes the flattened form, which it retains afterwards. The size most convenient for use must be according to the size of the copper-plate to be engraved. The sand cushion is not required in etching, its use being to support the plate steadily, and to allow it to be turned round easily when being cut with the graver, according to the requirements of the artist.

The *hand vice* is used to hold the plate by one corner or edge, during the time it is heated and smoked, as afterwards to be described. It is sufficiently large if you can hold up the plate by it with one hand three or four minutes when it is fastened to the edge.

Gravers are small tools, formed of a handle, about an inch long, and a blade or cutting part, about 3 inches l[redacted]ng part being formed of a lozenge-shaped piece of steel, ground to a bevelled edge. For such gravers as are to cut thin lines, the blade is narrow; for others the blade is nearly square, and the point consequently of a more obtuse angle. For steel engravings, the gravers are required to be tempered harder than for copper. As already remarked, gravers are not required in etching.

Needle, etching needle, or *dry point*.—This useful instrument may be compared to a round, fine-pointed brad awl, set at the end of a handle, a quarter of an inch thick, and 4 or 5 inches long. An excellent substitute may be easily made by any person by taking a thick short needle, such as is used by tailors and sempstresses, called a *blunt*, (No. 3 and No. 5 are appropriate,) and inserting them into the end of a common pencil, so that it shall be firmly fixed; the point not projecting above a quarter of an inch. When one needle gets blunt, another is easily made to replace it. The use of the etching needle is to scratch through the surface of the ground that the copper may be laid bare in places previous to *biting in*, and also to scratch any faint lines on the copper itself afterwards, to throw in a shade or make a line, &c., being done with much less labor than with a graver. It is in the latter use that it is called a *dry point*.

A *burnisher*.—This is a straight piece of steel, gradually tapering to a point, and made everywhere perfectly smooth and bright. The use of it is implied by the name; it is to burnish or rub out lines erroneously made, or else to soften down such as have been made too deeply, and consequently print too dark.

The *scraper* is a triangular piece of steel, fastened to a handle, the edges being ground sharp. The use of this tool is to scrape out such parts as require to be removed, and are so deep that the burnisher is not sufficient to remove them.

(To be continued)

PALINGENESY.

(Resumed from page 127, and concluded.)

We are told by Kircher himself, in his "Ars Magnetica," that he had a long-necked phial, hermetically sealed, containing the ashes of a plant which he could revive at pleasure, by means of heat; and that he showed this wonderful phenomenon to Christina, queen of Sweden, who was highly delighted with it; but that having left this valuable curiosity one cold day in his window, it was entirely destroyed by the frost. Father Schott also asserts, that he saw this chemical wonder, which according to his account, was a rose revived from its ashes; and he adds, that a certain prince having requested Kircher to make him one of the same kind, he chose rather to give up his own than to repeat the operation.

The process, indeed, as taught by Kircher, is so complex and tedious, that it would require no small patience to follow it. Father Schott relates it at full length, in his work entitled "Jocoseria Naturæ et Artis," and he calls it the imperial secret, because the Emperor Ferdinand purchased it from a chemist, who gave it to Kircher.

This emperor was exceedingly fortunate; for it was to him that the philosopher, who had the secret of the philosopher's stone, addressed himself, and gave a proof of his art by transmuting, as is said, in his presence, three pounds of mercury into two pounds and a half of gold.

We must however content ourselves with pointing out the places where the curious may find this singular process; for besides the length of the description, nothing seems less calculated to succeed. Digby, therefore, and many others who followed this method, did not obtain a favorable result; and there is reason to believe that their zeal for palingenesy would induce them to omit nothing that was likely to insure them success.

Dobrezensky, of Negropont, has also given a process for the resurrection of plants, which seems to have been attended with not better success. We are at least told by Father Schott, that the attempts of Father Conrad proved ineffectual, and he therefore supposes that Dobrezensky did not reveal all the circumstances of the process, but kept the most important to himself.

What then can be said in opposition to all these authorities? Undoubtedly, the Polish physician was a quack, and we shall describe hereafter a method of producing a false palingenesy, which, if performed with art and in a proper place, may impose on credulous persons. To be convinced that Dobrezensky, of Negropont, was a mere imposter, we need only read the "Technica Curiosa," or the "Jocoseria Naturæ et Artis," of Father Schott; for he had the impudence to pretend that he could pull out the eye of an animal, and in the course of a few hours restore it, by means of a liquor, which he no doubt sold as a remedy for sore eyes. He even tried it on a cock. A person who could assert such an impudent falsehood, in regard to one fact, would do the same in regard to another

The authority of Father Schott will certainly be of little weight with those who have read his works. In regard to the testimony of Kircher, we confess that we find some embarrassment: a Jesuit certainly would not wilfully have told a falsehood. But Kircher was a man of a warm imagination, passionately fond of every thing singular and extraordinary, and who had a strong propensity to believe in the marvellous. What can be expected from a man of that character? He often thinks he sees what he does not see, and if he deceives others he is first deceived himself.

Some persons go still farther, and assert that an animal may be revived from its ashes. Father Schott, in his "Physica Curiosa," even gives the figure of a sparrow thus revived in a bottle. Gaffarel, in his "Unheard of Curiosities," believes in this fact, and considers it as a proof of the possibility of the general resurrection of bodies. This pretended revival, however, is a chimera, still more absurd than the former; and which, at present, it would be ridiculous to attempt seriously to refute.

In short, what reasonable man can with Kircher believe, that if the ashes of a plant be scattered on the ground, plants of the like kind will spring up from them, as he says he frequently experienced? Who can admit as a truth, that if crabs be burnt, and then distilled, according to a process given by Digby, there will be produced in the liquor small crabs of the size of a grain of millet, which must be nourished with ox's blood, and then left to themselves in some stream? Yet we are told by Sir Kenelm that this he himself experienced. It is therefore impossible to clear him from the charge of imposture, unless we suppose that by some means or other he was led into error. However, it is certain that Digby, with great zeal and a considerable share of knowledge, had a strong propensity to all the visions of the occult and cabalistic sciences. In our opinion, he was one of those visionaries known under the name of *Rosicrusians.*

An illusory kind of Paligenesy.—We have already mentioned a kind of sleight of hand, by means of which, credulous people might easily be imposed on, and induced to believe in the reality of palingenesy. We shall now discharge our promise by describing it.

Provide a double glass jar of a moderate size, that is a vessel formed of two jars placed one within the other, in such a manner, that an interval of only a line in diameter may be left between them. The vessel may be covered by an opaque top or lid, so disposed, that by turning it in different directions, the inner jar may be raised from or brought nearer to the bottom of the exterior one. In the interior jar, on a base representing a heap of ashes, place the stem of an artificial rose. Into the lower part of the interval between the two jars introduce a certain quantity of ashes, or some solid substance of a similar appearance; and let the remainder be filled with a composition made of one part of white wax, twelve parts of hog's lard, and one or two of clarified linseed oil. This oily compound, when cold, will entirely conceal the inside of the jar; but when brought near the fire, if done with dexterity, it will dissolve, and by shaking the lid, under a pretence of hastening the operation, the compound may be made to fall down into the bottom of the exterior jar. The rose in the interior one will then be seen; and the credulous spectators, who must not be suffered to approach too near, will be surprised and astonished. When you wish to make the rose disappear, remove the jar from the fire, and by a new sleight of hand make the dissolved semi-transparent wax flow back into the interval between the jars. By accompanying this manœuvre with proper words, the gaping spectators will be more easily deceived, and will retire firmly persuaded that they have seen one of the most curious phenomena that can be exhibited by the united efforts of chemistry and philosophy

ANALYSIS OF MINERAL WATERS.

THE examination of mineral waters with a view to ascertain their ingredients, and thence their medical qualities and the means of compounding them artificially, is an object of considerable importance to society. It is, likewise, a subject which deserves to be attended to, because it affords no mean opportunity for the agreeable practice of chemical skill. But this investigation is more especially of importance to the daily purposes of life, and the success of manufactures. It cannot but be an interesting object, to ascertain the component parts and qualities of the waters daily consumed by the inhabitants of large towns and vicinities. A very minute portion of unwholesome matter, daily taken, may constitute the principal cause of the differences in salubrity, which are observable in different places. And with regard to manufactures, it is well known to the brewer, the paper-maker, the bleacher, and a variety of other artists, of how much consequence it is to them, that this fluid should either be pure, or at least not contaminated with such principles as tend to injure the qualities of the articles they make. This analysis has accordingly employed the attention of the first chemist. Bergmann has written an express treatise on the subject, which may be found in the first volume of the English translation of his Essays. Kirwan published a valuable volume on the analysis of waters.

The topography of the place where these waters rise is the first thing to be considered. By examining the ooze formed by them, and the earth or stones through which they are strained and filtered, some judgment may be formed of their contents. In filtering through the earth, and meandering on its surface, they take with them particles of various kinds, which their extreme attenuation renders capable of being suspended in the fluid that serves for their vehicle. Hence we shall sometimes find in these, water; siliceous, calcareous, or argillaceous earth; and, at other times, though less frequently, sulphur, magnesian earth, or, from the decomposition of carbonated iron, ochre.

The investigation of mineral waters consists,—1. In the examination of them by the senses:—2. In the examination of them by reagents:—3. In the analysis properly so called.

The examination by the senses consists in observing the effect of the water as to appearance, smell, and taste.

The appearance of the water, the instant in which it is pumped out of the well, as well as after it has stood for some time, affords several indications, from which we are enabled to form a judgment concerning its contents. If the water be turbid at the well, the substances are suspended only, and not dissolved; but if the water be clear and transparent at the well, and some time intervenes before it becomes turbid, the contents are dissolved by means of carbonic acid.

The presence of this gas is likewise indicated by small bubbles, that rise from the bottom of the well, and burst in the air while they are making their escape, though the water at the same time, perhaps, has not an acid taste. This is the case, according to Count Razoumowski, with respect to the tepid spring in Vallais, and the cold vitriolated chalybeate springs at Astracan. But the most evident proof of a spring containing carbonic acid is the generation of bubbles on the water being shaken, and their bursting with more or less noise, while the air is making its escape.

The sediment deposited by the water in the well is likewise to be examined; if it be yellow, it indicates the presence of iron; if black, that of iron combined with sulphur; but chalybeate waters being seldom sulphuretted, the latter occurs very rarely. As to the color of the water itself, there are few instances where this can give any indication of its contents, as there are not many substances that color it.

The odour of the water serves chiefly to discover the presence of sulphuretted hydrogen in it; such waters as contain this substance have a peculiar fetid smell, somewhat resembling rotten eggs.

The taste of a spring, provided it be perfectly ascertained by repeated trials, may afford some useful indications with respect to the contents. It may be made very sensible by tasting water, in which the various salts that are usually found in such waters are dissolved in various proportions. There is no certain dependence, however, to be placed on this mode of investigation; for in many springs, the taste of sulphate of soda is disguised by that of the sea salt united with it. The water too is not only to be tasted at the spring, but after it has stood for some time. This precaution must be particularly observed with respect to such waters as are impregnated with carbonic acid; for the other substances contained in them make no impression on the tong[redacted]acid has made its escape; and it is for the same reason that these waters must be evaporated in part, and then tasted again.

Though the specific gravity of any water contributes but very little towards determining its contents, still it may not be entirely useless to know the specific weight of the water, the situation of the spring, and the kind of sediment deposited by it.

The examination of the water by means of reagents shows what they contain, but not how much of each principle. In many instances this is as much as the inquiry demands; and it is always of use to direct the proceedings in the proper analysis.

It is absolutely necessary to make the experiment with water just taken up from the spring, and afterwards with such as has been exposed for some hours to the open air; and sometimes, a third essay is to be made with a portion of the water that has been boiled and afterward filtered. If the water contain but few saline particles, it must be evaporated; as even the most sensible reagents do not in the least affect it, if the salts, the presence of which is to be discovered by them, are diluted with too great a quantity of water. Now, it may happen, that a water shall be impregnated with a considerable number of saline particles of different kinds, though some of them may be present in too small a quantity; for which reason the water must be examined a second time, after having been boiled down to three-fourths.

The substances of which the presence is discoverable by reagents, are:—

1. Carbonic acid. When this is not combined with any base, or not with sufficient to neutralize it, the addition of lime-water will throw down a precipitate soluble with effervescence in muriatic acid. The infusion of litmus is reddened by it;—but the red color gradually disappears, and may be again restored by the addition of more of the mineral water. When boiled it loses the property of reddening the infusion of litmus. According to Pfaff, the most sensible test of this acid is acetate of lead.

2. The mineral acids, when present uncombined in water, give the infusion of litmus a permanent red, even though the water has been boiled. Bergmann has shown that paper stained with litmus is reddened when dipped into water containing $\frac{1}{5041}$ of sulphuric acid.

3. Water, containing sulphuretted hydrogen gas, is distinguished by the following properties; it exhales the peculiar odour of sulphuretted hydrogen gas. It reddens the infusion of litmus fugaciously. It blackens paper dipped into a solution of lead, and precipitates the nitrate of silver black or brown.

4. Alkalis, and alkaline and earthy carbonates, are distinguished by the following tests:—the infusion of turmeric, or paper stained with turmeric, is rendered brown by alkalis; or reddish-brown, if the quantity be minute. This change is produced when the soda in water amounts only to $\frac{1}{2417}$ part. Paper stained with Brazil wood, or the infusion of Brazil wood, is rendered blue; but this change is produced also by the alkaline and earthy carbonates. Bergmann ascertained, that water containing $\frac{1}{3643}$ part of carbonate of soda, renders paper stained with Brazil wood blue. Litmus paper reddened by vinegar, is restored to its original blue color. This change is produced by the alkaline and earthy carbonates also. When these changes are fugacious, we may conclude, that the alkali is ammonia.

5. Fixed alkalis exist in water that occasions a precipitate with muriate of magnesia after being boiled. Volatile alkali may be distinguished by the smell; or it may be obtained in the receiver by distilling a portion of the water gently, and then it may be distinguished by the above tests.

6. Earthy and metallic carbonates are precipitated by boiling the water containing them; except carbonate of magnesia, which is precipitated but imperfectly.

7. Iron is discovered by the following tests:—The addition of tincture of galls gives water, containing iron, a purple or black color. This test indicates the presence of a very minute portion of iron. If the tincture have no effect upon the water, after boiling, though it colors it before, the iron is in the state of carbonate. The following observations of Westrumb on the color which iron gives to galls, as modified by other bodies, deserve attention. A violet indicates an alkaline carbonate, or earthy salt. Dark purple indicates other alkaline salts. Purplish-red indicates sulphuretted hydrogen gas. Whitish, and then black, indicates sulphate of lime. Mr. Phillips has lately ascertained, that, while the iron is little oxided, the presence of lime rather facilitates the application of this test; but the lime prevents the test from acting, provided the iron be considerably oxidized. The Prussian alkali occasions a blue precipitate in water containing iron. If an alkali be present, the blue precipitate does not appear unless the alkali is saturated with an acid.

8. Magnesia and alumina. The presence of these earths is ascertained by the following tests:—Pure ammonia precipitates them both, and no other earth, provided the carbonic acid have been previously separated by a fixed alkali and boiling.—Lime-water precipitates only these two earths, provided the carbonic acid be previously removed, and the sulphuric acid also, by means of nitrate of barytes.

(To be continued.)

MEMORANDA.

To Whiten Ivory that has become Red or Yellow.—Boil alum in water; into this immerse your ivory, and let it remain in an hour; then rub the ivory with a cloth, wipe it clean with wet linen rag, and lay it in a moistened cloth to prevent its drying too quickly, which causes it to crack.

Evaporation of the Sea.—In the beginning of the last century the philosophical world was agitated with an inquiry into the origin of rivers, the vast waters of which are unceasingly being discharged into the sea. One party contended for the existence of a large mass of water within the bowels of the earth, which supplied not only the rivers but the ocean itself. Another party asserted, that the waters of the ocean were conveyed back by some subterraneous passages to the land, and being filtrated in their passage, returned again to the sea in the course of the rivers; this opinion was however too absurd to be long maintained, being contrary to all the known principles of hydrostatics. In opposition to these hypotheses, our celebrated countryman, Halley, contended that the immense deposition of water in consequence of evaporation was fully adequate to the whole supply, which opinion was confirmed by the following experiment. He took a vessel of water, made of the average saltness of the ocean, which he ascertained by an hydrometer; and having placed a thermometer in it, he brought it by a chafing-dish to the heat of the air in our hottest summer. This vessel with the thermometer in it, he placed in one scale, which he nicely counterbalanced by putting weights in the opposite scale. After two hours he found that about the sixteenth part of an inch in the depth of the surface had escaped in vapor, and consequently, that in twelve hours, the length of a natural day, one-tenth of an inch would be evaporated. It follows from this experiment that every ten square inches of the surface of the water yield a cubic inch of water in vapor per day, every square mile 6,914 tons, and every square degree 33 millions of tons. Now, calculating the Mediterranean at 40° long, and 4 broad, we have a surface of 160 square degrees, from whence will evaporate 3,280 millions of tons per day, a quantity, which renders it highly probable that the rivers may be supplied by the deposition of water raised by the process of evaporation.

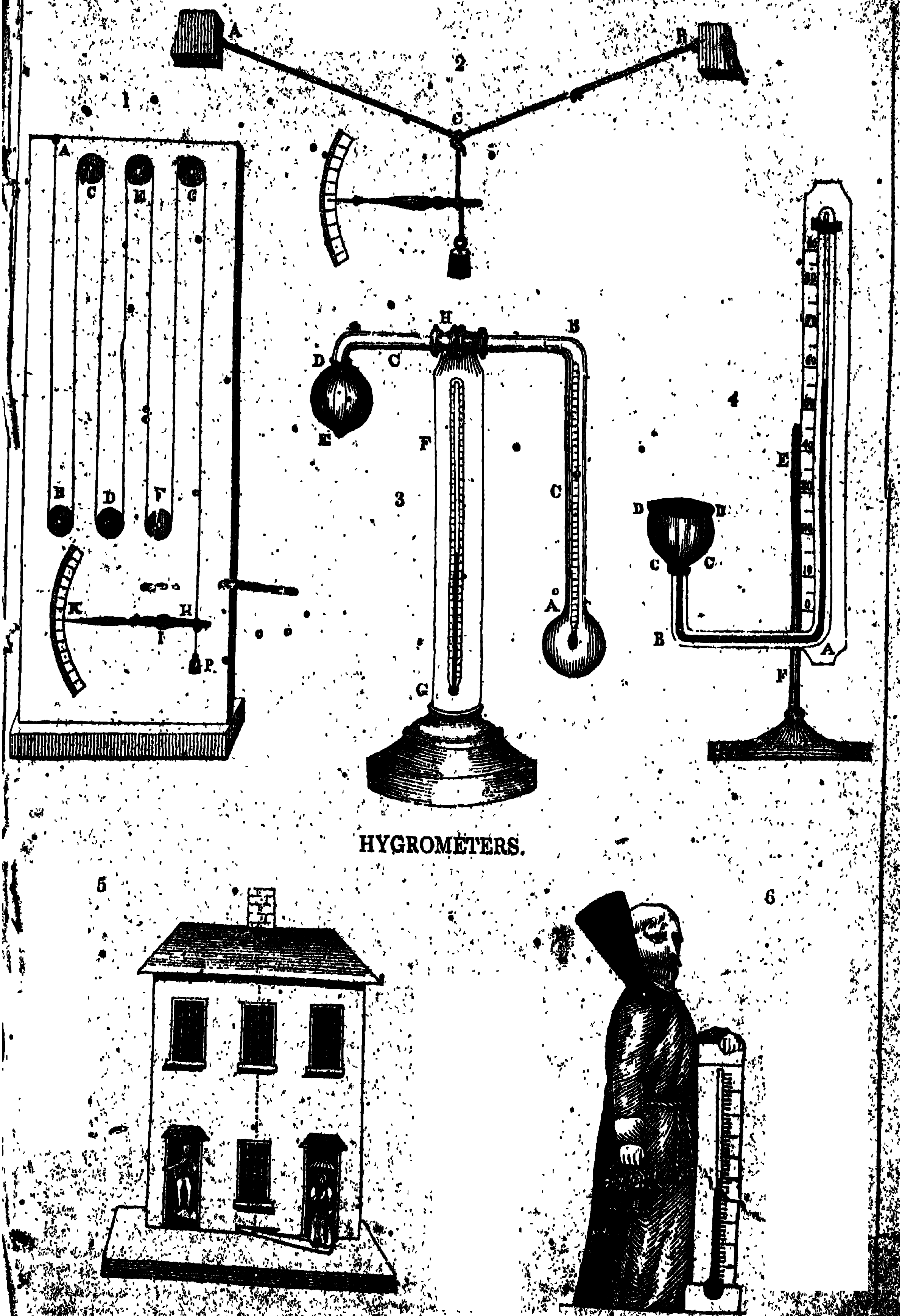
New Mode of Preparation of the Daguerréotype Plates, by which portraits can be taken in the short space of time from five to fifteen seconds, according to the power of light, discovered by A. Claudet in the beginning of May, 1841.—"My improvement," says the author, "consists in using for the preparation of the plates, a combination of chlorine with iodine, in the state of chloride of iodine. I follow the preparation recommended by Daguerre. After having put the plate in the iodine box for a short time, and before it has acquired any appearance of yellow color, I take it out, and pass it for about two seconds over the opening of a bottle containing chloride of iodine; and immediately I put it again in the iodine box, where it acquires very soon the yellow color which shows that the plate is ready to be placed into the camera obscura. I have substituted for the chloride of iodine, chloride of bromine, and have found nearly the same result; but I prefer chloride of iodine as producing a better effect; and besides, on account of the noxious smell of bromine. The result of my preparation is such that I have operated in ten seconds, with the same apparatus which, without any chlorine, required four or five minutes; when using only the original preparation of Daguerre, I have obtained an image of clouds in *four seconds.*"—*Athenæum.*

Salting Meat.—The method for which a patent has been lately taken out by Mr. Payne, is thus described.—The meat to be salted is placed within a strong iron vessel, which is closed in an air-tight manner, and the air exhausted from it by means of an air-pump; a communication is then opened with a brine vessel, whence the brine flows into the receiver, until it is about half filled; the air-pump is then again worked to draw off every particle of air from the meat, &c. The brine is then permitted to fill the receiver, and a farther quantity is injected by means of a common forcing-pump, the pressure being regulated by a safety-valve loaded with about 100 or 150lb. upon the square inch. After remaining under this pressure for about fifteen minutes, the meat is cured, and may be taken out of the receiver.

Extraordinary Phenomenon at Derby.—During a heavy thunder-storm, which happened recently, the rain poured down in torrents mixed with half-melted ice, and, incredible as it may appear, hundreds of small fishes and frogs in great abundance descended with the torrents of rain. The fish were from half an inch to two inches long, and a few considerably larger, one weighing three ounces; some of the fish have very hard pointed spikes on their backs, and are commonly called stickle-backs. Many were picked up alive. The frogs were from the size of a horse-bean to that of a garden-bean; numbers of them came down alive, and jumped away as fast as they could, but the bulk were killed by the fall on the hard pavement. We have seen some alive which appear to enjoy themselves, in a glass with water and leaves in it.—*Sheffield Patriot.*

Engraving in Relief by means of Voltaic Electricity.—Mr. G. H. Hoffman, of Margate, proposes certain modifications of the processes at present in use, the result of which he conceives will be found greatly superior. A flat copper-plate, such as is used by engravers, is to be covered with thick soft etching-ground; in this grooves are to be scratched or cut, or dots stippled with a blunt or sharp point down to the copper, as in common etching: the plate is then to be immersed, and the copper deposited in the usual manner, and the electric action to be continued until the deposit forms one solid sheet. The compound plate is then to be heated over a spirit lamp, so that the etching ground may be melted and run out. The plates are then to be separated; and, after carefully washing with hot oil of turpentine, the engraving will appear, polished, sharp and perfect.

Blood.—Dr. Carbonel, of Barcelona, has employed serum of blood on an extensive scale in painting. Mixed with powdered quicklime or slaked lime to a proper consistence it is easily applied on wood, to which it thus gives a coating of stone color, that dries quickly without any bad smell, and resists the action of sun and rain. The wood should be first covered with a coating of plaster, the composition must be mixed as it is used, and the serum must not be stale. It may be also used as a cement for water pipes and for stones in building under water.



HYGROMETERS.

HYGROMETERS

It is well known that the air is not only susceptible of acquiring more or less heat but also of becoming more or less humid. It belongs therefore, to philosophy, to measure this degree of moisture, especially as it has a great influence on the human body, on vegetation, and many other effects of nature. This gave rise to the invention of the *hygrometer*, an instrument proper for measuring the humidity of the air.

1 As fir wood is highly susceptible of participating in the dryness or humidity of the air, an idea has been conceived of applying this property to the construction of one of these instruments. For this purpose, a very thin small fir board is placed between two vertical immoveable pillars so that the fibres stand in a horizontal direction, for it is in the lateral direction or that across its fibres that fir and other kinds of wood are distended by moisture. The whole of the board should be formed of pieces of wood cut across the grain and fit tightly between the pillars when quite dry. As the board gets wet, it of course expands and becomes bent, the degree of flexure shows the degree of humidity. This invention is ingenious, yet of little practical utility. The wood retains its moisture a long time after the air has lost that with which it is charged; besides, the board gradually becomes less sensible to the impressions of the air, and therefore produces little or no effect.

2 An hygrometer may be made also of the beard of a wild oat fixed on a small column placed in the centre of a round box, the other extremity of the beard passes through the centre of the cover of the box, the circumference of which is divided into equal parts, in the last place a small index made of paper is adapted to the extremity of the beard. In order to afford access to the air, it is necessary that the sides of the box should be perforated with holes, that the air may have a perfect passage through it. When this instrument is exposed to drier or moister air, the small index by turning round either in the one direction or the other, indicates the state of the atmosphere, but this hygrometer, which is exceedingly sensible at first, gradually loses this property, consequently, it is a very imperfect instrument.

3 Suspend a small circular plate by a string or piece of catgut fastened to its centre of gravity, and let the other end of the string be attached to a hook. According as the air is more or less moist, you will see the small plate turn round in one direction or in another. This small machine may be covered with a bell glass, to prevent its being deranged by the agitation of the air, but the bell must be elevated above the base that the air may have access to the string.

4 If a piece of catgut or whipcord be made fast at one extremity, A be conveyed over different pullies, as B, C, D E, F G, (Fig 1), so as to make several turns backwards and forwards and if a weight P be suspended from the other extremity, it may be easily seen that it must rise or fall in a more sensible manner in consequence of the moisture or dryness of the air, according as the number of turns backwards and forwards is greater. But this will be indicated better if an index H K, turning on a pivot I, and placed in such a manner that the part I K shall be much longer than I H, be made fast to the extremity of the cord H. The slightest change in the moisture of the air will be manifested by the point K of the index.

5 An hygrometer may be constructed also in the following manner:—Extend a cord, 5 or 6 feet in length between the supports A and B (Fig 2) and suspend from the middle of it C a weight P by a thread P C, the weight will as before ascend or descend according to the degree of humidity of the air actuating the index attached to it, in a similar manner to the former instrument.

6 Music may also be employed to indicate the dryness or moisture of the air. The sound of a flute is higher during dry than during wet weather. So also stringed instruments left in tune are well known to require tuning again each day or hour they are played upon, not merely because of the stretching of the strings, but because of the weather. Let a piece of catgut then extended between two bridges be put in a state of vibration so as to agree with any certain note in music according to a tuning fork. When the weather becomes moister the string will emit a lower sound, and the contrary will be the case when the air becomes drier.

7 The *balance hygrometer* is well known: it consists of a scale beam suspended on a proper stand, bearing at one end a sponge dipped in salt and water and then dried in the air and at the other end a weight which is exactly equivalent to it. So you may put into the scale of a balance any salt that attracts the moisture of the air and a corresponding weight into the other scale. In these cases both of the sponge and the scale of salt this part will sink down during damp weather, and thereby indicate the state of the atmosphere. An index, to point out the different degrees of drought or moisture may be easily adapted to it. This instrument is, however, worse than any of the rest; for salt, immersed in moist air, becomes charged with a great deal of humidity, but loses it very slowly, when the air becomes dry; potash, the chloride of lime, and numerous other salts, even imbibe moisture, until they are reduced to a liquid state.

8 The hygrometers commonly sold at the toy shops are constructed on the principle of that described in paragraph No 3. One of them consists of a kind of box, the fore part of which represents an edifice with two doors, on one side of the metal plate which turns round or as is substituted here, merely a double arm or suspended balance beam, stands the figure of a person with an umbrella as a defence from the rain, and on the other, a person without a hat or in gay attire, as if aware of the continuance of fine weather. The appearance of one of these [illegible] damp, and that of the other, dry weather (see Fig 5). Another toy hygrometer, upon the same principle, is made to represent a friar, with a large moveable cowl over his head, and bearing in one hand a thermometer that the instrument may serve the double purpose of an hygrometer and a thermometer (see Fig 6). The hygrometrical part is very easily constructed. Behind the neck of the figure projects a thin tin tube, about 2 inches long, this tube comes quite through the thin board upon which the figure is painted. On the back part of the hood is a hole, which fits loosely over the tube, so that, as far as this is concerned, the hood may move round in any direction. To the front side of the hood, at a part corresponding with the end of the tube is glued the end of a piece of catgut, the other end is drawn through the tube and fastened by passing through the middle of a cork, which fits the backward end of the tube;—thus, the catgut being fixed at one end, as it twists or untwists with changes of the weather, the hood

is drawn over the monk's head if wet, or rests upon his shoulders when dry. These pretended hygrometers can serve for no other purpose than to amuse children; the philosopher must observe that as the variations of humidity are transmitted to this instrument by degrees, it will indicate moisture or drought, when the state of the atmosphere may be very different. The circumstance, too, of these hygrometers being generally placed in a room where a fire is kept, does not contribute to their usefulness.

To produce a perfect hygrometer, as well as any other philosophical instrument, we must call in the aid of science, and with its unerring principles as a guide, several perfect hygrometers have been constructed, we shall at present describe two of the best of them—those of Professor Daniell, of King's College, London, and of Mr Page. To understand the principles upon which these instruments are constructed, it is to be premised that "the temperature at which dew *begins* to be deposited, is a measure of the moisture of the air." Referring to Figure 3, which is a representation of Daniell's hygrometer, the ball A is of black glass, about 1½ inch in diameter, and connected with a transparent glass ball D of the same size, by a bent tube C, one eighth of an inch in diameter. A portion of sulphuric ether, sufficient to fill about three-fourths of the ball A, is introduced, a small mercurial thermometer, with an elongated bulb, is fixed inside the limb A B, and the atmospheric air being expelled, the whole is hermetically sealed. The ball D is covered with muslin, and the whole is supported on a brass stem F G, on which is another delicate thermometer. The tube can be removed from the spring tube H, and the whole instrument, with a phial of ether, neatly packed in a box, which may be carried in the pocket.

The dew point, and, consequently, the humidity of the air, is ascertained thus. The ether being all brought into the ball A, by means of the tube, the balls are placed perpendicularly, the temperature of the air is noted by the common thermometer, which is attached to the centre stand F G, and ether is gradually dropped on the muslin cover of D.— The cold produced by the evaporation of the ether, condenses the elastic ethereal vapor within the ball, and if the thermometer in the limb be noted at that instant we obtain the true *dew-point* of air at the temperature shown by the other thermometer. To ascertain the degree of humidity, we must have recourse to a set of tables constructed for the purpose which may be found as originally constructed by Dr Dalton, for every degree of the thermometer, in the fifth volume of the "Manchester Transactions," or by the following formula, which ascertains the moisture contained in a foot of air. Its weight in grains will be equal to $\frac{\text{[illegible]}\,2 \times p}{11\text{[illegible]} \times t}$, where t is the temperature of the external air, and p the elasticity of the ethereal vapor, at the temperature shown by the interior thermometer.

The instrument invented by Mr Jones, is described in the "Tracts of the Society of Useful Knowledge," as being on exactly the same principle as the original invention of Daniell, but simpler in construction, more compact, and less expensive.— Its appearance would certainly scarcely imply as much. It is seen in Figure 4, and consists of a delicate mercurial thermometer, with its tube at A B, bent so as to bring its cylindrical ball C parallel with and at a little distance from its stem. The bulb is one inch long, and is terminated by a surface of black glass which projects somewhat beyond the sides of the bulb. The bulb below the flattened surface is covered with black silk. The instrument is supported on the wire E F, which is attached to the scale by a pivot at top that allows the black surface to be inclined to the sight, and the whole as in the case of the former instrument, is, with a phial of ether, contained in a small case. When used, the temperature of the air is first noted; the ether is poured on the silk cover of the bulb, and the condensation of the dew is seen on the black extremity of the bulb. The calculation to find the degree of humidity is the same as before, an ordinary thermometer must be used along with this instrument,—Daniell's has one attached to it.

CALOTYPE PICTURES.

Mr. H. F. Talbot, so well known for his researches and discoveries, relative to photographic drawing, and of which art we have, from time to time, recorded the progress, has been and is still occupied with this interesting subject, and seems to have brought it to a degree of perfection hitherto unknown, which the following paper, read at the last meeting of the Royal Society, will show. Our readers will, by comparison, remark that there are so many points about it so entirely different from the old process, that it may justly be considered a new art altogether, and as such, Mr. Talbot has given it the new name of *Calotype*. We give Mr Talbot's paper entire, and nearly verbatim.

Preparation of the Paper.—Take a sheet of the best writing paper, having a smooth surface, and a close and even texture. The watermark, if any, should be cut off, lest it should injure the appearance of the picture. Dissolve 100 grains of crystallized nitrate of silver in six ounces of distilled water.— Wash the paper with this solution, with a soft brush, on one side, and put a mark on that side whereby to know it again. Dry the paper cautiously at a distant fire, or else let it dry spontaneously in a dark room. When dry, or nearly so, dip it into a solution of iodide of potassium, containing 500 grains of that salt dissolved in one pint of water, and let it stay two or three minutes in this solution. Then dip it into a vessel of water, dry it lightly with blotting-paper, and finish drying it at a fire, which will not injure it even if held pretty near; or else it may be left to dry spontaneously. All this is best done in the evening by candlelight. The paper, so far prepared, the author calls *iodized paper*, because it has a uniform pale yellow coating of iodide of silver. It is scarcely sensitive to light, but, nevertheless, it ought to be kept in a portfolio, or a drawer, until wanted for use. It may be kept for any length of time without spoiling or undergoing any change, if protected from the light. This is the first part of the preparation of Calotype paper, and may be performed at any time. The remaining part is best deferred until shortly before the paper is wanted for use. When that time is arrived, take a sheet of the *iodized paper* and wash it with a liquid prepared in the following manner.—Dissolve 100 grains of crystallized nitrate of silver in two ounces of distilled water, add to this solution one-sixth of its volume of strong acetic acid. Let this mixture be called A. Make a saturated solution of crystallized gallic acid in cold distilled water. The quantity dissolved is very small. Call this solution B. When a sheet of paper is wanted for use, mix together the liquids A and B in equal volumes, but only mix a small quantity of them at a time, because the mixture does not keep long without spoiling. I shall call this mixture the *gallo-nitrate of silver.* Then take a sheet of *iodized paper* and wash it over with this *gallo-nitrate of silver*, with a soft brush, taking care to wash it on the side which has been previously marked.' This operation should be performed by candlelight. Let the paper rest half a minute, and then dip it into water. Then dry it lightly with blotting paper, and finally dry it cautiously at a fire, holding it at a considerable distance therefrom. When dry, the paper is fit for use. The author has named the paper thus prepared *Calotype paper*, on account of its great utility in obtaining the pictures of objects with the camera obscura. If this paper be kept in a press it will often retain its qualities in perfection for three months or more, being ready for use at any moment; but this is not uniformly the case, and the author therefore recommends that it should be used in a few hours after it has been prepared. If it is used immediately, the last drying may be dispensed with, and the paper may be used moist. Instead of employing a solution of crystallized gallic acid for the liquid B, the *tincture of galls* diluted with water may be used, but he does not think the results are altogether so satisfactory.

Use of the Paper.—The *Calotype paper* is sensitive to light in an extraordinary degree, which transcends a hundred times or more that of any kind of photographic paper hitherto described. This may be made manifest by the following experiment:—Take a piece of this paper, and having covered half of it, expose the other half to daylight for the space of *one second* in dark cloudy weather in winter.—This brief moment suffices to produce a strong impression upon the paper. But the impression is latent and invisible, and its existence would not be suspected by any one who was not forwarned of it by previous experiments. The method of causing the impression to become visible is extremely simple. In consists in washing the paper once more with the *gallo-nitrate of silver*, prepared in the way before described, and then warming it gently before the fire. In a few seconds the part of the paper upon which the light has acted begins to darken, and finally grows entirely black, while the other part of the paper retains its whiteness. Even a weaker impression than this may be *brought out* by repeating the wash of gallo-nitrate of silver, and again warming the paper. On the other hand, a stronger impression does not require the warming of the paper, for a wash of the gallo-nitrate suffices to make it visible, without heat, in the course of a minute or two. A very remarkable proof of the sensitiveness of the Calotype paper is afforded by the fact stated by the author, that it will take an impression from simple moonlight, not concentrated by lens. If a leaf is laid upon a sheet of the paper, an image of it may be obtained in this way in from a quarter to half an hour. This paper being possessed of so high a degree of sensitiveness, is therefore well suited to receive images in the camera obscura. If the aperture of the object-lens is one inch, and the focal length fifteen inches, the author finds that *one minute* is amply sufficient in summer to impress a strong image upon the paper of any building upon which the sun is shining. When the aperture amounts to one-third of the focal length, and the object is very white, as a plaster bust, &c., it appears to him that *one second* is sufficient to obtain a pretty good image of it. The images thus received upon the Calotype paper are for the most part invisible impressions. They may be made visible by the process already related, namely, by washing them with gallo-nitrate of silver, and then warming the paper. When the paper is quite blank, as is generally the case, it is a highly curious and beautiful phenomenon to see the spontaneous commencement of the picture, first tracing out the stronger outlines, and then gradually filling up all the numerous and complicated details. The 'artist' should watch the picture as it developes itself, and when, in his judgment, it has attained the greatest degree of strength and clearness, he should stop further progress by washing it with the fixing liquid.

The fixing process.—To fix the picture, it should be first washed with water, then lightly dried with blotting paper, and then washed with a solution of *bromide of potassium*, containing 100 grains of that salt dissolved in eight or ten ounces of water. After a minute or two it should be again dipped in water and then finally dried. The picture is in this manner very strongly fixed, and with this great advantage, that it remains transparent, and that, therefore, there is no difficulty in obtaining a copy from it. The Calotype picture is a *negative* one, in which the lights of nature are represented by shades; but the copies are *positive*, having the lights conformable to nature. They also represent the object in their natural position with respect to right and left. The copies may be made upon Calotype paper in a very short time, the invisible impressions being *brought out* in the way already described. But the author prefers to make the copies upon photographic paper, prepared in the way which he originally described in a memoir read to the Royal Society in February, 1839, and which is made by washing the best writing paper, *first* with a weak solution of common salt, and *next* with a solution of nitrate of silver. Although it takes a much longer time to obtain a copy upon this paper, yet, when obtained, the tints appear more harmonious and pleasing to the eye; it requires, in general, from three minutes to thirty minutes of sunshine, according to circumstances, to obtain a good copy on this sort of photographic paper. The copy should be washed and dried, and the fixing process (which may be deferred to a subsequent day) is the same as that already mentioned. The copies are made by placing the picture upon the photographic paper, with a board below and a sheet of glass above, and pressing the papers into close contact by means of screws or otherwise. After a Calotype picture has furnished several copies, it sometimes grows faint, and no more good copies can then be made from it. But these pictures possess the beautiful and extraordinary property of being susceptible of revival. In order to revive them and restore their original appearance, it is only necessary to wash them again by candlelight with gallo-nitrate of silver, and warm them; this causes all the shades of the picture to darken greatly, while the white parts remain unaffected. The shaded parts of the paper thus acquire an opacity which gives a renewed spirit and life to the copies, of which a second series may now be taken, extending often to a very considerable number. In reviving the picture it sometimes happens that various details make their appearance which had not before been seen, having been latent all the time, yet, nevertheless, not destroyed by their long exposure to sunshine. The author terminates these observations by stating a few experiments calculated to render the mode of action of the sensitive paper more familiar.—1. Wash a piece of the *iodized* *paper* with the gallo-nitrate; expose it to daylight for a second or two, and then withdraw it. The paper will soon begin to darken spontaneously, and will grow quite black.—2. The same as before, but let the paper be warmed. The blackening will be more rapid in consequence of the warmth.—3. Put a large drop of the gallo-nitrate on one part of the paper, and moisten another part of it more sparingly, then leave it exposed to a very faint daylight; it will be found that the lesser quantity produces the greater effect in darkening the paper; and, in general, it will be seen that the most rapid darkening takes place at the moment when the paper becomes nearly dry; also, if only a portion of the paper is moistened, it will be observed that the edges or boundaries of the moistened part are more acted on by light than any other part of the surface.—4. If the paper, after being moistened with the gallo-nitrate, is washed with water and dried, a slight exposure to daylight no longer suffices to produce so much discoloration; indeed it often produces none at all. But by subsequently washing it again with the gallo-nitrate and warming it, the same degree of discoloration is developed as in the other case (experiments 1 and 2). The dry paper appears, therefore, to be equal, or superior in sensitiveness to the moist; only with this difference, that it receives a *virtual* instead of an *actual* impression from the light, which it requires a subsequent process to develope.

IMPROVEMENT IN THE DAGUERROTYPE.

The urgency with which the artists of Paris have demanded from M. Daguerre information respecting a new discovery of his relative to the Daguerrotype, appears to have forced a communication from him earlier than he would, himself, have chosen to make it—his experiments not being complete—not having yielded, as yet, perfect evidences of the extraordinary artistic results which he expects from them. M. Arago, at the sitting of the 28th June, explained to the Academy the new principle of which the discovery consists, but on the authority of M. Daguerre alone, and without the production of any specimens in proof of his assertions. Contrary to what we had before imagined, M. Arago withholds the sanction of his authority, declaring that he has not, himself, seen any of the experiments or results;—but the principle itself is one of greater importance in its scientific bearing, than for any artistic application of which it is susceptible. The history and description of the discovery is as follows:—Abandoning the search, in which so many have been engaged, after some fresh substance more sensitive to the action of light than those hitherto employed, M. Daguerre submitted his plate, merely washed with iodine, in the ordinary manner, to the influence of electricity; and found that it had attained such an excessive degree of sensibility, that no mechanism exists sufficiently rapid in its action to expose it uniformly to the impression of light—that is, a plate so electrified and placed in the *camera obscura* undergoes, during the one unappreciable moment occupied in opening and shutting the diaphragm which covers the objective glass, such varied degrees of impression, that the portion first brought into contact with the light is already too profoundly marked ere it can touch the later portions. The result is a confused and clouded image. To meet the difficulty, M. Daguerre states, that he has employed a substance, (which, however, he does not name,) less sensitive than the ordinary combination of iodine with silver; and, in the next, instead of subjecting his plate to the continued action of the electric fluid, he admits the intervention of this mysterious agent for a single instant only. In more precise terms, the plate so prepared and disposed in the camera, may be exposed, without injury, to the action of the light for a certain time; and to communicate to it the exquisite sensibility in question, a single electric spark suffices; after which, the plate resuming its inertness, time is afforded to withdraw it from the influence of the light—and the operation is complete. It is not easy to imagine the artistic effects which will result from this remarkable discovery;—from the rapid action of the electric spark, vast assemblages of men, in the moment of animation and impulse, may be caught for eternity, with the gesture of the moment in the limbs, and its expression on the lips of each. History may be written, by picture, even while its deeds are acting; and nature, in her subtlest movements, be painted by herself. M. Daguerre, however, is not satisfied with such results as he has yet obtained; and, in yielding to the demand for his secret, has declined confirming it by his specimens, till he has succeeded in making them perfect. Meantime, the important part of his communication is the scientific phenomenon, itself—this wonderful effect of electricity on the chemical combination, exposed to the action of the rays of light.

LIGHT.

The cause of those sensations which we refer to the eyes, or that which produces the sense of seeing. The phenomena of light and vision have always been regarded as one of the most interesting branches of natural science; though it is only since the days of Newton that they have been examined with such care as to afford grounds for any safe speculation respecting the nature of light, and the mode of its propagation through space. But the solution of these two questions is involved in very great difficulty, for notwithstanding the splendid discoveries of that immortal philosopher, and the long train of interesting and important facts which have been investigated since his time, and more particularly since the beginning of the present century, the true theory of light still remains an enigma. This does not arise from any difficulty there is in framing an hypothesis which shall afford a mechanical explanation of the various phenomena, but from the circumstance that more hypotheses than one have been imagined by which all the phenomena can be explained, not merely in a general way, but with the precision of numerical calculation.

Properties of Light.—Experiments of the simplest and most familiar kind suffice to show that light is propagated from luminous bodies in all directions. Provided nothing intervenes to intercept the light, they are seen in all situations of the eye. Thus, the flame of a lamp is visible from every part of the sphere of which it occupies the centre; and the same is the case with respect to a phosphorescent body, an electric spark, a ball heated red-hot, or light having any other source. The sun throws its light, not only on the earth, but on the planets and comets, and every other body in the firmament.

Another property of light is, that in a homogeneous medium it is always propagated in straight lines. This is evident from various considerations. The forms of shadows correctly represent the outlines of the objects which produce them, as seen from the luminous body, which could not be unless the light proceeded in straight lines from the extremities of the objects to the borders of the shadow. If three plates of metal, each pierced with a small hole, are placed at some distance behind each other, and in such positions that the three holes are exactly in one straight line, the light will pass freely through them; but if the holes are not exactly in a straight line, no light will pass. In like manner, if a number of similar objects are placed behind each other in a straight line, the first renders all the others invisible to an eye placed in the same line. We cannot see through a bent tube.

A third property of light is, that it requires time for its propagation. The velocity with which it passes from one point to another is, however, so great, that, with respect to any terrestrial distances, the passage may be considered as instantaneous. But astronomy furnishes the means, not only of detecting its propagation, but of measuring its velocity with great precision. The eclipses and emersions of Jupiter's satellites become visible about 16 min., 26 sec. earlier when the earth is at its least distance from Jupiter, than when it is at its greatest. Light, therefore, occupies above a quarter of an hour in passing through the diameter of the earth's orbit. Now, the sun's distance from the earth being nearly 95,000,000 of miles, it follows that light must travel through space with the prodigious, though finite, velocity of 192,500, or nearly 200,000 miles, in a second of time, and consequently would pass round the earth in the eighth part of a second. Astounding as this conclusion is, no result of science rests on more certain evidence. It is also proved, by the phenomena of aberration, that the light of the sun, planets, and all the fixed stars, travels with one and the same velocity.

When light in its progress encounters an obstacle, or enters a different medium, it undergoes certain modifications, depending on the nature of the body on which it falls, or the medium into which it enters. When it falls on a smooth polished surface, a portion of it is regularly reflected; that is to say, it is returned from the surface at an angle equal to the angle of incidence, and pursues its course in a straight line as before the reflection. The quantity of light thus reflected depends on the nature and polish of the surface, and on the angle of incidence, being greatest when that angle is small: but it is calculated that even the brightest, and most opaque surfaces, mercury for example, do not reflect more than three-fourths of the incident light. Another portion of it enters the medium, and there (if the medium is homogenous,) pursues a rectilinear course, but differing from its former direction. In this case it is said to be refracted. The angle of refraction depends on the nature of the medium, each different medium having its own peculiar law[illegible] action on light. In many media, com[illegible]stances, the liquids and most of the uncryst[illegible]ht from its ori- the whole of the refracted light. In many others, ginal direction at the media, part of the refracted as in most cryst[illegible]urse, and another part it a dif- light follow[illegible] two portions acquiring, at the same [illegible], different physical properties. In this case the refraction is said to be double. A third portion of the light falling on a body is neither reflected nor refracted regularly, but is scattered in all directions; and it is this portion which renders bodies visible. All bodies on which light falls absorb a certian part of it; more or less in proportion to the opacity. In perfectly opake bodies the absorption is total, and the light does not penetrate to a sensible depth under the surface. In others it penetrates farther; but even in the most transparent it is gradually stifled and lost. A depth of only seven feet of pure water is required to extinguish one half of the incident light.

Solar light, refracted by a prism or other body, is separated into a multitude of rays of different colors, each of which afterwards proceeds in its course independently of all the others. These differently colored rays possess different physical properties, and different degrees of refrangibility. It is to this dispersion or separation of light by refraction that we owe all the pleasure derived from the variegated hues of natural bodies. The investigation of the laws of the dispersion of the colored rays forms the subject of *chromatics*. One of the principal facts connected with it is, that the dispersion of the rays by different refracting substances is not proportioned to the refraction; the dispersive power of some substances being greater than that of others, while their refracting power is less. This fact led to the important discovery of the *achromatic telescope*.

Light, on being regularly reflected or refracted, undergoes a modification termed *polarization*, in virtue of which it presents, on encountering another medium, different phenomena of reflection and refraction from those presented by light which has not undergone such modification. When a ray of light, having acquired this modification, is made to fall on a plane reflecting surface under a certain angle of incidence, no portion of it will be reflected; the whole is transmitted or absorbed. But, in the case of ordinary light, some portion is always reflected from a polished surface, whatever be the angle of incidence; the light has therefore acquired the property of being acted upon in a particular way; whence Malus, who first investigated this subject in a philosophical manner, gave the phenomena the name of *polarization*, from its analogy to the effect produced by a magnet on a series of needles.

The last property of light which we shall notice, as important towards forming a theory of its propagation, is that to which Dr. Young gave the name of *interference*. Under certain circumstances, the rays of light exercise a mutual influence on each other; increasing, diminishing, or modifying each other's effects according to certain laws. This mutual action of the rays on each other, gives rise to a great number of the most intricate phenomena of optics, and affords a sufficiently simple explanation of them, in numer[illegible]ere no other explanation has [illegible] found on other hypotheses.

Th[illegible] Light.—Two different theories have [illegible] divided the opinion of philosophers, respecting the nature and propagation of light. One of these consists in supposing it to be composed of particles of excessive minuteness, projected from the luminous body with a velocity equal to nearly 200,000 miles in a second. This hypothesis was adopted by Newton, and, till recently, has been acquiesced in by the greater number of writers on optics. The other hypothesis supposes light to be produced by the vibrations, or undulations of an ethereal fluid of great elasticity, which pervades all space and penetrates all substances, and to which the luminous body gives an impulse which is propagated with inconceivable rapidity, in spherical superficies, by a sort of tremor or undulation, as sound is conveyed through the atmosphere, or a wave along the surface of water. Both of these hypotheses are rendered probable by the great number of phenomena of which they afford a mechanical explanation; but they are both, also, attended with very great difficulties. Other theories have also been proposed; but they have not met with such general attention from philosophers as to make it necessary to explain them.

(To be continued.)

MOSAIC PICTURES.

It is well known that Mosaic-work consists of variously shaped pieces of colored glass enamel; and that when these pieces are cemented together, they form those regular and other beautiful figures which constitute tessellated pavements. These pavements, the work of the ancient Romans, have frequently been dug up in England and other countries. The principal manufactory of Mosaic pictures, in the present day, is at Rome, and belongs to his Holiness the Pope.

The building in which the establishment is situated is large, and contains a collection of enamels drawn into the form of sticks. These are arranged, according to their colors, in an extensive suit of rooms. The number of shades of color is 17,000.

The enamel, consisting of glass mixed with metallic coloring matter, is heated for eight days in a glass-house, each color in a separate pot. The melted enamel is taken out with an iron spoon, and poured on polished marble placed horizontally; and another flat marble slab is laid upon the surface, so that the enamel cools into the form of a round cake, of the thickness of $\frac{4}{10}$ths of an inch.

In order to divide the cake into smaller pieces, it is placed on a sharp steel anvil, called tagliulo, which has the edge uppermost; and a stroke of an edged hammer is given on the upper surface of the cake, which is thus divided into long parallelopipeds, or prisms, whose bases are $\frac{3}{10}$ths of an inch square. These parallelopipeds are again divided across their length by the tagliulo and hammer, into pieces of the length of $\frac{8}{10}$ths of an inch, to be used in the Mosaic pictures. Sometimes the cakes are made thicker, and the pieces larger.

For smaller pictures, the enamel, whilst fused, is drawn into long parallelopiped, or quadrangular sticks; and these are divided across by the tagliulo and hammer, or by a file; sometimes, also, these pieces are divided by a saw without teeth, consisting of a copper blade and emery; and the pieces are sometimes polished on a horizontal wheel of lead with emery.

Gilded Mosaic is formed by applying the gold-leaf on the hot surface of a brown enamel, immediately after the enamel is taken from the furnace; the whole is put into the furnace again for a short time, and when it is taken out, the gold is firmly fixed on the surface. In the gilded enamel, used in Mosaic, at Rome, there is *a thin coat of transparent glass over the* gold.

The ancient Romans, besides the enamel for Mosaic, made other works in enamel. Winklemann mentions ancient tities of a kind of glass or enamel, for paving the floors of rooms; and he describes a small picture composed of filaments of enamel of different colors, agglutinated together by fusion, each transverse section of this gave a picture like that at the extremity. The antique pastes, or artificial gems, are also products of art allied to enamel.

Anciently, the paste in which the pieces of Mosaic were imbedded, called, in Italy, stucco, was composed of a measure of quick-lime quenched in water, and three measures of pounded marble; these were made into a mass with water and white of eggs;—and this was called Marmoratum: but this paste hardens too rapidly, so that it is hard before the workman has time to insert the pieces, and it is injured by damp more readily than the cement made with oil.

The paste now used, is composed of a measure of quenched quick-lime, and three measures of powdered travertine stone; these are mixed with linseed oil, and are stirred and worked up every day with a trowel. The mass is at first level on the surface, but afterwards swells up. Each day some oil is added, to prevent the mass from becoming dry and intractable. The mass is ready in a shorter time in warm weather than in cold; in summer the mass is at its perfection in twenty days; this is known from its ceasing to swell, the water that was in the lime having evaporated; the mass is then uniform throughout, like an ointment. In winter, and when the air is moist, it requires a month to bring the paste to perfection.

The wall to which the Mosaic is to be applied, must have the lime taken off its surface; then furrows, an inch deep, are formed on the wall, to fix the cement. For the same purpose large-headed nails are driven in, and wire is stretched from one nail to another. After this, the wall thus prepared, is painted over with linseed oil. Then the cement is laid on, to the extent of a surface of as many inches as can be executed before the cement dries. The plasticity and softness of the cement lasts about twenty days; after that the oil exudes, and the lime and travertine become a hard mass. The cement made with linseed oil is yellow; that made with white of eggs is white, and the white cement is considered to be a character for distinguishing the old Mosaic from the modern; but some of the modern is also made with white cement.

MEDICAL QUALITIES OF SEA-WATER.

Two very important agents, endowed with peculiar virtues in reference to the human constitution, have of late years been much commended and employed in the practice of medicine. I allude to iodine and bromine—both of which have been detected by recent analyses in sea-water. Independent of these, there are other very active ingredients in sea-water. The first is chloride of sodium, which exists in the proportion of 1 to 35, or, in other words, a pint of sea-water contains 216½ grains—that is to say, something less than ½ oz. of common salt. The second is what medical men call muriate of magnesia, which is a combination of chlorine with magnesium—a salt endowed with well-marked properties on the human frame, and which constitutes one of the active ingredients of Pullna water. To complete this analysis, it should be stated that the same pint of sea-water contains also 18 grains and ⅛ of Epsom salts, 11¼ grains of sulphate of lime, with a very trifling quantity of carbonate of lime. After this account it will be readily admitted that sea-water is, in fact, a mineral water to all intents and purposes, and that we may, therefore, look with as much confidence for beneficial effects from its employment, whether externally or internally, provided it be judiciously recommended, as from the employment of other mineral waters—proportionate to, and in accordance with, their respective chemical composition.—*Granville's Spas of England.*

NOTES ON THE MONTH OF JULY.

Weather at	Average of the Thermometer	Average of the Barometer.	Quantity of Rain.
LONDON	66 3	29 89	2 191 inch.
EDINBURGH...	60 6	29·41	2 546
DUBLIN	61 13	29 92	2 614

THE ANIMAL KINGDOM.

Birds.—About or before this season most song birds become silent. The Blackbird, the Pippet Lark, the Willow Wren, and several other birds though they become silent now, resume their notes in September. The Cuckoo leaves off its curious notes The Quail, however, begins to make itself heard. Mole hills may be observed, some very much larger than others: when a hill of enlarged dimensions is discovered we may be almost certain of finding the nest beneath. Supposing the weather favorable we find the Snake basking on the bank, the Hedgehog sleeping on the common, and the pretty little Lizards nimbly running through the brake. The insect race is in its full vigour, and abounds in all situations. The Dragon Flies skim along the margin of the streams and ponds, settling from time to time on the water plants around. The Cuckoo Spit, the Plant Louse, and the Frog-hopper are everywhere in abundance. It is in this month that the Caterpillars of most of the Hawk-Moths are to be sought for. That of the Puss-Moth may be found on the lower branches of Willow trees, and must be sought by the eye, for beating the branches will not make them quit their hold as it does the *Noctua*.

THE VEGETABLE KINGDOM.

Plants indigenous to our climate are now in their greatest number and beauty. The whole of nature seems but a wilderness of flowers. In June they were but struggling into existence, now they are luxuriant. To enumerate even a hundredth part of the long list of plants in flower would be extremely tedious; yet there are some whole tribes which seem to choose July as their season of blossoming; thus in the early part of the month, the Grasses and the Roses are almost all in blossom. The umbelliferous plants and the Brambles must now be sought for. The extensive family of the Cruciferœ or Cabbage tribe are, during this month, more particularly in perfection, though a few of them are in blossom at a much earlier season. The Sedums or Stone Crops, the House-Leeks, the Rock Rose tribe and the Saxifrages, and numerous others, deserve particular attention at this season. These remarks relate but to our wild plants. The garden flowers are no less abundant and rich, showing the luxuriance of summer without the incipient decay of the succeeding month. If we have lost the Peony, and the Lilac, and the Tulip, we can, instead of them, admire the Rose, the Pink, and the Honeysuckle, and a thousand others equally sweet and beautiful.

GARDENING OPERATIONS.

The gardener begins to witness the success and reap the benefit of his toil in the preceding winter and spring. His chief employment will be in gathering his Peas, and his early ripe Fruits, his Gooseberries, Currants, Cherries, Strawberries, and Raspberries. He will not, however, neglect to propagate from cuttings of such plants as are going out of flower; nor forget to pipe and lay the Pink tribe, and gather the seeds as they ripen of such plants as may have flowered early.

NOTES ON THE MONTH OF AUGUST.

Weather at	Average of the Thermometer.	Average of the Barometer.	Quantity of Rain.
LONDON	65 85	30 06	0 824
EDINBURGH....	60·6	29 83	1 996
DUBLIN	62·82	30·17	5 858

ANIMATED NATURE.

INSECTS no less abound now than they did in July. Flies are well known to swarm in the houses, and Wasps, Hornets, Gnats, and Gad-Flies in the fields. Flying-Ants appear—Bees kill their Drones—the Swallow-tailed, and the Black-Eyed Marble Butterfly appear. Swallows, Martins, and some other birds of passage, begin in the latter part of the month to congregate, previous to undertaking their distant migrating expeditions, and Swifts already are departing. Various birds resume their spring notes. The Nuthatch chatters—the Stone Curlew whistles at night—the Goat-Sucker and young Owls make a noise in the evening, and the Robin Red-Breast sings. The young of animals, born in April and May, are in vigour, and rapidly attaining the size of their parents. Rabbits and Hares so prolific in the spring begin to cease their parental duties, their three or four broods having grown from under their care, and there being none others to succeed them. Young Partridges and Pheasants have attained to nearly their full size and strength.

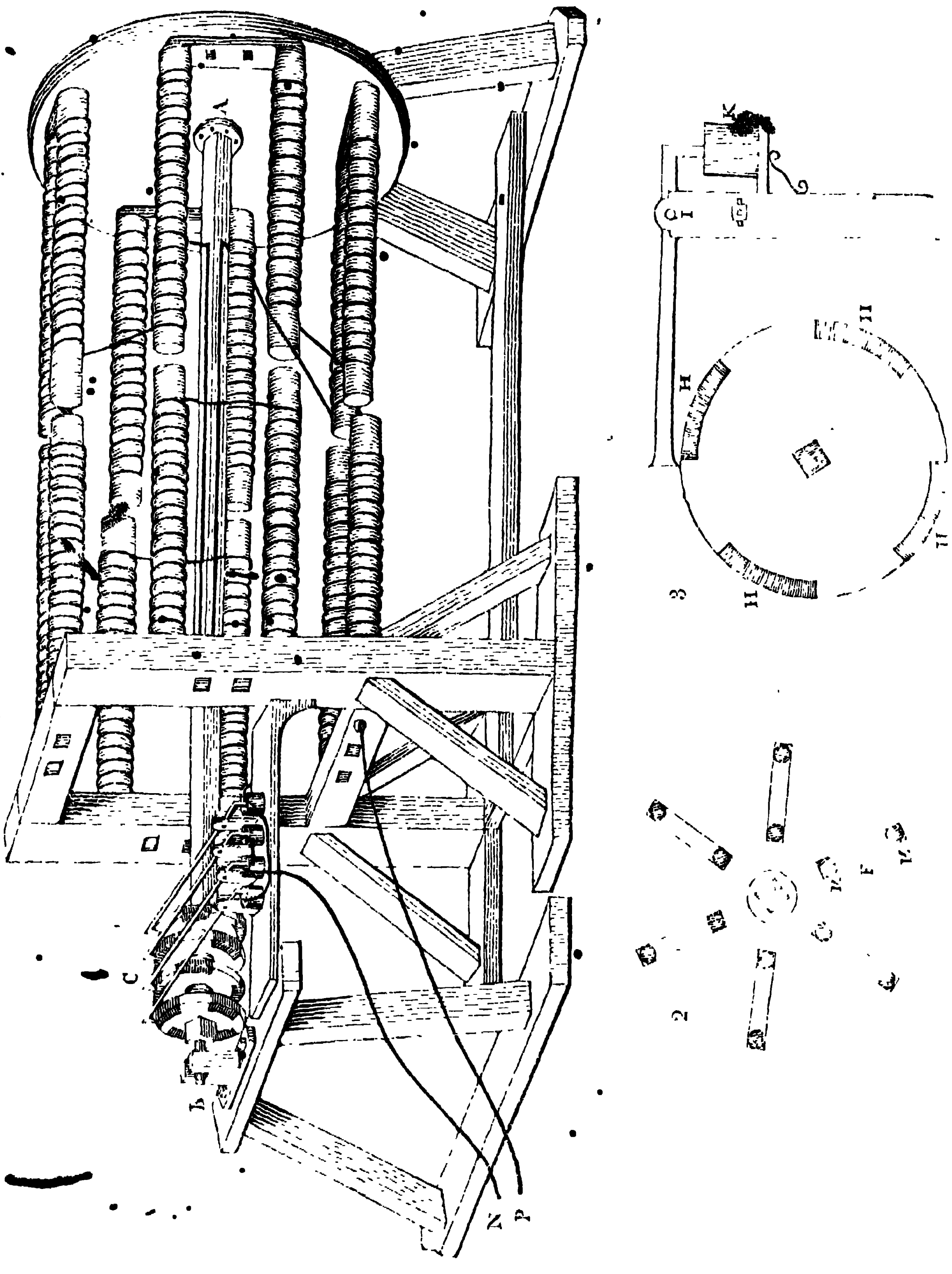
THE VEGETABLE KINGDOM.

The observations applicable to July, are no less appropriate here on the abundance of flowers; still as the season advances, we find some fading from our sight, and others of a more autumnal character making their appearance. We lose the beautiful Roses, and find but Hips in their place; we still see the scarcely less beautiful Bramble Flower, but it is joined with the young Blackberry. Trees have lost their flowers and show more or less ripe fruit. These are the general effects of the change of season, yet it is said, and with perfect truth, that the first week in August is, if fine, the best in all the year for the botanist, as he will then find the greater number of *rare* plants, in almost any situation he may search for them. Mountainous districts are, previous to this, too cold to yield many flowers, the marshes have till now been too much overflowed; the waters too cold, until the heats of July re-awakens the vegetable energy, dries up the superabundance of moisture, and invigorates the plant so as to produce its flowers now. Another advantage the botanist now enjoys which he did not previously, he can in most cases procure the seed and seed-vessel of his specimens, and such is in very numerous tribes absolutely necessary.

GARDENING OPERATIONS.

The gardener will have to attend to his crops of vegetables and fruit, for most kinds grown in gardens are now in perfection, as well as his hot-house productions. His forced Fruits should all be ready early in the month, Peaches, Nectarines, and Grapes, Pine-Apples, and Melons: In the open ground, besides culinary vegetables, he will gather Plums, Apricots, and the earlier Pears and Apples for the use of the table; while, at intervals, he will not forget to sow Mignionette for winter flowering, and such biennials as may have been before neglected.

Fig. 1.



NEW ELECTRO-MAGNETIC ENGINE.

Steam Superseded. An Account of the newly-invented Electro-magnetic Engine, for the Propulsion of Locomotives, Ships, Mills, &c.: and also applicable to the Processes of Spinning, Turning, Grinding, Sawing, Polishing, &c., and every Species of Mechanical Movement. Price 2s., pages 36.

SUCH is the title of a very small work, pretty generally distributed throughout London. It is a translation from the German. Upon looking into this work we expected something exceedingly new, and at the same time exceedingly excellent. We were somewhat disappointed, therefore, in finding that it gives a description of the first machine, invented two or three years ago by M. Jacobi. Without its describing other machines of more simplicity, greater power, and of less weight and expense; besides wholly leaving out the account of Mr. Sturgeon's, and whatever else has been done in this country, relative to the moving of machines by electro-magnetism. This might have been excused in the original German work, but it is in some degree to be regretted that this small treatise was not made more useful by introducing various matters of this kind in notes by the translator, who is well able to have supplied them.

With this drawback the work is good, giving an account of the principal parts of the reasoning and experiments of M. Jacobi, who, whatever may be the merits of others, must always hold a distinguished rank among electricians. We give some of the illustrative cuts, and the following extracts, explanatory of them, from the book itself, trusting that those who are interested, will, by purchasing the work, (which may be had of any bookseller in London,) glean from it those unerring principles of science and fact, which will assist in their own endeavours to understand, and it may be to construct some simplification of M. Jacobi's invention.

"The principal figure of the cut, (No. 1,) represents a magnetical apparatus, in which eight bars, (four bars of soft iron in the shape of horse-shoes,) are symmetrically attached to a wooden frame, revolving round a horizontal axle, A, and eight others similar, arranged on a sufficiently strong fixed frame. The arrangement of the bars admits of every possible variety, it being only necessary that they be symmetrically arranged, and that their poles shall pass each other as closely as possible. Since in all probability the centre of the magnetical gravity is situated at some little distance from the extremity, as is the case with the ordinary magnetic bars, it would be better to arrange it so that the axes of the cylindrical bars should be at right angles to one another, instead of parallel, as in the figure. The form given in the plate is attended with some other inconveniences, as regards the formation of the spiral line of copper wire, which must be first bent over another cylinder of the same dimensions. These spirals must be quite close to the cylinder, but be preserved from contact with it by being wrapped in silk, for the sake of isolation.

"The several bars attached to the moveable and stationary frames are then converted into electro-magnets, by being encircled by the wire of a voltaic battery, and their extremities are north and south poles alternately. If, then, a slight impulse be given to the moveable frame, it will continue to revolve in the direction given, until the contrary poles come opposite one another; after a few oscillations the motion would be suspended, were it not, that, by means of an ingenious contrivance of Jacobi, which he terms the *commutator*, the moment dissimilar poles come opposite one another, the poles of the moveable or stationary bars are reversed, and thus the original conditions of motion are renewed.

"The cut No. 3, gives a front view of the bars, and No. 2, a side view of the commutator. There are four plates of copper attached to the rotatory axle, which likewise bears the frame on which the electro-magnets are fastened; the plates are connected by copper tubes, two and two, and each pair of plates perfectly separated from the other by the interposition of a hollow axle of japanned wood, or any similar isolating substance. The edge of each plate is accurately divided into eight parts, four of which, H H H H, (No. 2,) are cut out, and duly filled with ebony, so that the sectors and the metal present a perfectly even surface. The plates are so arranged on the axle, that the sectors of wood and metal alternately correspond, as exhibited by the figure, No. 1. C C are copper levers, very moveable round their axes, and serving to conduct the current of the voltaic battery. Each lever is shaped like a hammer at the end, which rests on a corresponding plate.—The shorter arm is bent, and dips into the vessel K filled with mercury. These vessels (for there are four of them) are, as appears by the plate, connected with one another by means of a copper wire.

"The action of the *commutator* will be now readily understood. The levers are in constant connexion with the plates, but touch the metallic and isolating parts alternately. As they readily move round their axes, they fly from the slightest inequality of surface, and the friction which is thereby caused is very trifling. The spiral coils, which encircle the moveable bars, are united to one wire, branches of which are soldered to the pairs of plates of the commutator. The other spirals, encircling the fixed bars, are similarly joined, and the ends dip,[*] the one into a vessel of quicksilver, which is connected with the voltaic apparatus, and the other into one of the vessels of the *commutator*. Thus, by means of the commutator, the whole sixteen spirals form but one connecting wire. The voltaic apparatus consists of four troughs of copper, into which four plates of zinc dip. As soon as the large wooden frame is turned by the power of the voltaic pile, the commutator, which is attached to the same axis, will be likewise set in motion, and thus the reversal of the poles effected by means of the machine itself, provided that the commutation plates be so constructed that the extremities of the levers shall pass from one sector to the other.

"In September, 1837, by advice of the Minister of Public Instruction in Russia, a commission, consisting of Rear Admiral von Krusenstern, the Academicians, Foss, Ostragradski, Kupfer, and Lenz, Colonel Sololewski, and Lieutenant-Colonel Buratschock were appointed, under the guidance of Professor Jacobi, of Dorpat, with a view to endeavour, by experiment, to render electro-magnetism applicable to the working of machinery, and particularly to the propulsion of ships. The object of this commission appears in part obtained, as on the 25th of September, 1838, a vessel was set in motion on the Neva. An eight-oared galley, such as is usual in

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In our cut we have omitted the galvanic battery, it presenting nothing peculiar. The two wires, N and P, are those which proceed to it, one of them coming from the fixed bar, the other from the commutator, or from the moveable bars through the commutator.

the navy, was placed at the disposal of the commission, 28 feet in length, and 7½ in breadth; it was provided with paddles similar to those of a steam-packet, and the various apparatus were put on board. The insufficiency of many of the arrangements which had been made, was then, for the first time, apparent, and in consequence, the first experiment was in a measure proportionably unsuccessful. It had been intended to make experiments only in still water, but they succeded in propelling the vessel on the Neva, even against the stream. The speed attained in still water was three English miles per hour, and would have been greater had the weight on board, which was large, been properly distributed throughout the boat, which drew 2½ feet of water. The machine, when on board, occupied a space 12½ feet in breadth, and 2½ in length.

"The battery consisted of 320 pairs of plates, arranged along the sides of the boat, leaving sufficient room for twelve persons. The whole battery could be brought into play only for a short time, in consequence of a trifling fault in the connexion, which it was impossible to correct on the spot. The consumption of zinc, or rather the production of vitriol of zinc per horse power, could not be exactly ascertained; but it would appear from the experiments, that this could not be very considerable, inasmuch as the original weight of the zinc, being 400 pounds, and presenting a surface of 96 square feet, had decreased but 24 pounds in weight, during from two to three months that the experiments were continued.

"Provided the health of Professor Jacobi allow him, he intends constructing an electro-magnetic machine of 40 to 50-horse power, and to adapt it to the propulsion of a vessel. * * *

"Davenport, who has constructed the most powerful machines propelled by electro-magnetism, is said to have already applied some smaller ones to different objects, such as the working of printing-presses, principally of a few horse power. Davenport's machines are, at present, the most powerful and simple. (A description is in a former part of this Magazine.)

"We are indebted for a great improvement in electro-magnetic machines, to the mechanician Stoehrer, of Leipsic, who has constructed a machine as a model, the perfect simplicity and easy construction of which will, in all probability, ensure its application in the room of all other moving powers. It is worked at present but by four elements, each consisting of a copper cylinder filled with vitriolic acid, in which a zinc plate is hung, and sets a lathe in motion, which is applied to the turning of small brass articles. The expense of this power for twenty-four hours is one shilling, one half of which is fully covered by the pure metallic copper which is obtained.

"Stoehrer constructed this model last year on the principles laid down by Jacobi; and some time after, Wagener, of Frankfort, constructed a similar model, for which a reward of 100,000 florins was guaranteed him by the German Diet, as soon as the plan should be carried out on a large scale.

"This execution on a large scale has, according to the latest accounts, succeeded most brilliantly; for a saw-mill is at present worked by electro-magnetism in Bavaria, and this new power has already realized the most sanguine expectations. A locomotive is also propelled by it.

"It is, therefore, to be expected that electro-magnetism will soon play an important part, and unquestionably supersede steam, which is so much more dangerous and expensive, and every other power with which we are as yet acquainted.—Stoehrer is convinced that, with 100 zinc elements, as above mentioned, (equal to 15 horse power,) he can propel a train of waggons with the usual number of passengers, from Leipsic to Dresden on the railroad, at an expense of but six shillings, whilst the expense at present is about five pounds sterling.

"We thus arrive at a standard of the extraordinary economy and power of these new machines: notwithstanding their immense power, they can, nevertheless, be instantly stopped by a child; nothing further being necessary to stop the machine than to lift the connecting-rod out of the vessel.

"The extent by which this power may yet, and must in time, be perfected is sufficiently clear, from the fact of its being applicable, with the greatest advantage, for grinding, turning, spinning, and innumerable other mechanical processes.

"We feel, therefore, justified in calling the attention of mechanics to this novel power."

ANALYSIS OF MINERAL WATERS.

(Resumed from page 135.)

9. Sulphuric acid exists in waters that form a precipitate with the following solutions:—muriate, nitrate, or acetate of barytes, strontian, or lime, or nitrate or acetate of lead. Of these, the most powerful by far is muriate of barytes, which is capable of detecting the presence of sulphuric acid uncombined, when it does not exceed the millionth part of the water. Acetate of lead is next in point of power. The muriates are more powerful than the nitrates. The calcareous salts are least powerful. All these tests are capable of indicating a much smaller proportion of uncombined sulphuric acid, than when it is combined with a base. To render muriate of barytes a certain test of sulphuric acid, the following precautions must be observed:—The muriate must be diluted; the alkalis or alkaline carbonates, if the water contain any, must be previously saturated with muriatic acid; the precipitate must be insoluble in muriatic acid; if boracic acid be suspected, muriate of strontian must be tried, which is not precipitated by boracic acid.—The hydrosulphurets precipitate barytic solutions, but their presence is easily discovered by the smell.

10. Muriatic acid is detected by nitrate of silver, which occasions a white precipitate, or a cloud, in water containing an exceedingly minute portion of this acid. To render this test certain, the following precautions are necessary:—The alkalis or carbonates must be previously saturated with nitric acid. Sulphuric acid, if any be present, must be previously removed by means of nitrate of barytes. The precipitate must be insoluble in nitric acid.—Pfaff says, that the mild nitrate of mercury is the most sensible test of muriatic acid; and the precipitate is not soluble in an excess of any acid.

11. Boracic acid is detected by means of acetate of lead, with which it forms a precipitate insoluble in acetic acid. But to render this test certain, the alkalis and earths must be previously saturated with acetic acid, and the sulphuric and muriatic acids removed by means of acetate of strontian and acetate of silver.

12. Barytes is detected by the insoluble white precipitate, which it forms with diluted sulphuric acid.

13. Lime is detected by means of oxalic acid, which occasions a white precipitate in water containing a very minute proportion of this earth. To render this test decisive, the following precautions are necessary :—The mineral acids, if any be present, must be previously saturated with an alkali. Barytes, if any be present, must be previously removed by means of sulphuric acid. Oxalic acid precipitates magnesia very slowly, whereas it precipitates lime instantly.

14. Silex may be ascertained by evaporating a portion of water to dryness, and re-dissolving the precipitate in muriatic acid. The silex remains behind undissolved.

By these means we may detect the presence of the different substances commonly found in waters; but as they are generally combined so as to form salts, it is necessary we should know what these combinations are. This is a more difficult task, which Mr. Kirwan teaches us to accomplish by the following methods :—

1. To ascertain the presence of the different sulphates.

The sulphates which occur in water are seven ;—but one of these, namely, *sulphate of copper*, is so uncommon, that it may be excluded altogether.—The same remark applies to sulphate of ammonia. It is almost unnecessary to observe, that no sulphate need be looked for, unless both its acid and base have been previously detected in the water.

Sulphate of soda may be detected by the following method :—Free the water to be examined of all earthy sulphates, by evaporating it to one-half, and adding lime-water as long as any precipitate appears. By these means the earths will all be precipitated except lime, and the only remaining earthy sulphate will be sulphate of lime, which will be separated by evaporating the liquid till it becomes concentrated, and then dropping into it a little alcohol, and, after filtration, adding a little oxalic acid.

With the water thus purified, mix solution of lime. If a precipitate appear, either immediately or on the addition of a little alcohol, it is a proof, that sulphate of potash or of soda is present. Which of the two may be determined, by mixing some of the purified water with acetate of barytes. Sulphate of barytes precipitates. Filter and evaporate to dryness. Digest the residuum in alcohol. It will dissolve the alkaline acetate. Evaporate to dryness, and the dry salt will deliquesce if it be acetate of potash, but effloresce if it be acetate of soda.

Sulphate of lime may be detected by evaporating the water suspected to contain it to a few ounces. A precipitate appears, which, if it be sulphate of lime, is soluble in 500 parts of water; and the solution affords a precipitate with the muriate of barytes, oxalic acid, carbonate of magnesia, and alcohol.

Alum may be detected by mixing carbonate of lime with the water suspected to contain it. If a precipitate appear, it indicates the presence of alum, or at least of sulphate of alumina; provided the water contains no muriate of barytes or metallic sulphates. The first of these salts is incompatible with alum. The second, may be removed by the alkaline prussiates. When a precipitate is produced in water by muriate of lime, carbonate of lime, and muriate of magnesia, we may conclude that it contains alum or sulphate of alumina.

Sulphate of magnesia may be detected by means of hydrosulphuret of strontian, which occasions an immediate precipitate with this salt, and with no other; provided the water be previously deprived of alum, if any be present, by means of carbonate of lime, and provided also that it contains no uncombined acid.

Sulphate of iron is precipitated from water by alcohol, and then it may be easily recognized by its properties.

2. To ascertain the presence of the different muriates.

The muriates found in waters amount to eight, or to nine if muriate of iron be included. The most common by far is muriate of soda.

Muriate of soda and of potash may be detected by the following method :—Separate the sulphuric acid by alcohol and nitrate of barytes. Decompose the earthy nitrates and muriates by adding sulphuric acid. Expel the excess of muriatic and nitric acids by heat. Separate the sulphates thus formed by alcohol and barytes water. The water, thus purified, can contain nothing but alkaline nitrates and muriates. If it form a precipitate with acetate of silver, we may conclude, that it contains muriate of soda or of potash. To ascertain which, evaporate the liquid thus precipitated to dryness.—Dissolve the acetate in alcohol, and again evaporate to dryness. The salt will deliquesce, if it be acetate of potash; but effloresce if it be acetate of soda.

Muriate of barytes may be detected by sulphuric acid, as it is the only barytic salt hitherto found in water.

Muriate of lime may be detected by the following method :—Free the water from sulphate of lime and other sulphates, by evaporating it to a few ounces, mixing it with alcohol, and adding last of all nitrate of barytes, as long as any precipitate appears. Filter the water; evaporate to dryness ;—treat the dry mass with alcohol; evaporate the alcohol to dryness; and dissolve the residuum in water. If this solution give a precipitate with acetate of silver and oxalic acid, it may contain muriate of lime. It must contain it in that case, if, after being treated with carbonate of lime, it give no precipitate with ammonia. If the liquid in the receiver give a precipitate with nitrate of silver, muriate of lime existed in the water.

Muriate of magnesia may be detected by separating all the sulphuric acid by means of nitrate of barytes. Filter, evaporate to dryness, and treat the dry mass with alcohol. Evaporate the alcoholic solution to dryness, and dissolve the residuum in water. The muriate of magnesia, if the water contained any, will be found in this solution. Let us suppose that, by the tests formerly described, the presence of muriatic acid and magnesia, in this solution, has been ascertained. In that case, if carbonate of lime afford no precipitate, and if sulphuric acid and evaporation, together with the addition of a little alcohol, occasion no precipitate, the magnesia is to be separated by the oxalic acid and alcohol, and the acid with which it was united is to be distilled off. If the liquid in the retort give a precipitate with nitrate of silver, the water contains muriate of magnesia.

Muriate of alumina may be discovered by saturating the water, if it contain an excess of alkali, with nitric acid, and by separating the sulphuric acid by means of nitrate of barytes. If the liquid, thus purified, give a precipitate with carbonate of lime, it contains muriate of alumina. The muriate of iron or of manganese, if any be present, is also decomposed, and the iron precipitated by this salt.

The precipitate may be dissolved in muriatic acid, and the alumina, iron, and manganese, if they be present, may be separated by the rules laid down below.

3. To ascertain the presence of the different nitrates. The nitrates but seldom occur in waters; but when they do, they may be detected by the following results:—

Alkaline nitrates may be detected by freeing the water examined from sulphuric acid by means of acetate of barytes, and from muriatic acid by acetate of silver. Evaporate the filtered liquid, and treat the dry mass with alcohol; what the alcohol leaves can consist only of the alkaline nitrates and acetate of lime. Dissolve it in water. If carbonate of magnesia occasion a precipitate, lime is present.—Separate the lime by means of carbonate of magnesia. Filter and evaporate to dryness, and treat the dried mass with alcohol. The alcohol now leaves only the alkaline nitrates, which may be easily recognized, and distinguished by their respective properties.

Nitrate of lime. To detect this salt, concentrate the water, and mix it with alcohol to separate the sulphates. Filter, and distil off the alcohol; then separate the muriatic acid by acetate of silver.—Filter, evaporate to dryness, and dissolve the residuum in alcohol. Evaporate to dryness, and dissolve the dry mass in water. If this last solution indicate the presence of lime by the usual tests, the water contained nitrate of lime.

To detect nitrate of magnesia, the water is to be freed from sulphates and muriates exactly as described in the last paragraph. The liquid, thus purified, is to be evaporated to dryness, and the residuum treated with alcohol. The alcoholic solution is to be evaporated to dryness, and the dry mass dissolved in water. To this solution potash is to be added, as long as any precipitate appears. The solution, filtered, and again evaporated to dryness, is to be treated with alcohol. If it leave a residuum consisting of nitrate (the only residuum which it can leave), the water contained nitrate of magnesia.

(To be continued.)

THE PHILOSOPHER'S STONE.

The philosopher's stone (formerly called *the work*, by way of excellence, or *chrysopea*, the transmutation of the base and imperfect metals into gold or silver) has, since time immemorial, been an object to which the attention of multitudes of people, either versed in chemistry or scarcely initiated in the science, has been directed. The vulgar once thought that it was the sole object of chemistry;—and it must, indeed, be allowed that it was in some measure the fault of those who first cultivated that noble branch of philosophy: there were few of them who did not suffer themselves to be blinded by the illusion of attempting to make gold.

But at present very few people are infatuated with the philosopher's stone; at any rate none of the enlightened chemists employ themselves with the means of making gold; but formerly there were many persons who, though they have scarcely an idea of the simplest operations of chemistry, wasted their time in vain attempts to regenerate that precious metal. They are often seen proceeding at hazard, and still imagining themselves on the point of succeeding; in the midst of poverty consoling themselves with the agreeable idea, that this indigence will be succeeded by the possession of immense treasures. They called themselves *adepts*, because they pretend to have reached to the summit of philosophy, *quasi summam sapientiam adepti*;—they spoke enigmatically and in an unintelligible manner, because mankind in general do not deserve to possess such a secret. Filled with empty pride, they cast a sardonic smile of contempt on the rational chemists, and on those who endeavoured to deduce phenomena from clear and established principles.

We might say to the searchers after the philosopher's stone, before attempting to make gold, first decompose and re-compose it; for if there be any method of ascertaining and demonstrating the constituent principles of any substance, it is that of decomposition and re-composition. We might say also to those alchemists, before you make for us the precious metals, such as gold and silver, make for us lead; for before you proceed to the most difficult, method requires that you should execute the easiest. But we are acquainted with no chemical operation which resolves either of these problems. Gold, as stubborn in regard to decomposition, as to composition, always remains the same, in whatever manner it be treated; it is only more or less attenuated, but is never in the state of calx. It has been kept for several years in fusion, without losing the least part of its weight.

But let us hear the alchemists, and learn what are their pretensions in regard to the formation of metals.

According to them, metals are all formed of an earth, which they call *mercurial*, but more or less mature, more or less mixed with heterogeneous matters, so that to convert the imperfect into the perfect metals, nothing was necessary but to free them from these heterogeneous matters, and to mature them.

All this is very fine: but who has proved the existence of this mercurial earth? who has proved that the difference among metals consists in this greater or less maturity? by what means is it to be produced? To these questions no solid answer can be given.

According to other alchemists, mercury contains in principle all the perfect metals; it has the splendour of them, and nearly the weight; it is even heavier than silver. If it is fluid and exceedingly volatile, it is because it is alloyed with impurities which degrade it. The question, then, is to fix the mercury, by freeing it from those properties. We should then have the mercury of the philosophers, which would require only a certain degree of baking to be brought to a red heat, and the result would be gold; brought to a white heat, it would furnish silver; nay, this matter would have such an activity on the impure parts of other metals, that by throwing a pinch of it into a crucible filled with melted lead, it would transmute it into silver or gold, according as it had been carried to a white or red heat. But the great matter is, how to destroy the impurities by which quicksilver is debased. Aristeus, a celebrated adept, teaches us the process in the clearest manner, in his "Code de Verité." "Take," says he, "king Gabertin, and the princess Beya, his sister, a young lady, beautiful, fair, and exceedingly delicate; marry them together, and Gabertin will die almost immediately. Be not, however, alarmed; after eighty days, Gabertin will revive from his ashes, and become more beautiful and more perfect than he was before his death; will beget with Beya a red child, more beautiful and perfect than themselves." After this, will any one pretend to say that the alchemists explain themselves obscurely? What true adept, for there are true and false, and every one thinks himself among the former, will not evidently see in this allegory the whole process of the fixation of mercury and of the powder of projection?

This language, and this affectation of obscure allegories, are no doubt very proper for making these pretended adepts be considered as finished and contemptible quacks, or, perhaps, as people whose brains have been deranged by the heat of their furnaces. But the partisans of their researches and follies allege pretended facts; and it is our business to make them known.

It is related that Helvetius, a physician and celebrated professor in Holland, having declaimed one day with great violence, in one of his lectures, against the vanity and absurdity of pretending to make gold, was visited by an adept, who gave him a certain powder, a pinch of which, thrown into a crucible, filled with melted lead, would transform it into gold: that the learned Dutchman did so, and obtained from his lead a considerable quantity of that metal. Helvetius then hastened to find the adept; but the latter had given him a false address, and was not to be found; for the chemists of this order never fail to disappear at the moment when they have given a proof of their profound knowledge.

The same thing occurred, it is said, to the emperor Ferdinand. An adept came to him, and offered to transform mercury into gold. Mercury was put into a crucible in the presence of the prince, and the adept having performed certain operations, a button of gold was found in the bottom of the vessel. But while those present were employed in examining and assaying the gold, the adept disappeared, to the great regret of the emperor, who already beheld in idea the immense treasures which he hoped to obtain by the acquisition of this grand secret.

At the sale of the effects left by M. Geoffroy, in 1777, there were three nails, which, as it was said, were a proof of the possibility of at least transmuting silver into a common metal, such as iron.—They were the work, as asserted, of a celebrated adept, who wished to prove to Geoffroy the possibility of the transmutation of metals. One of these nails was converted into silver, by being dipped in an appropriate liquor; the head of the other only having been dipped, the remainder of it was iron; and the point of the third having been dipped, that part was silver, and the head iron.

Notwithstanding these authorities, no one, of ordinary judgement, can have a belief in the philosopher's stone. It is very probable, that in all these pretended transmutations, there was some deception, even if the above accounts were true.

However, the alchemists pretend that all the fables of antiquity are nothing else than the process of the grand work explained symbolically. The conquest of the golden fleece, the Trojan war, the events which followed it, and the whole mythology, are only emblems of the chrysopea, prudently veiled by the ancient philosophers, who did not wish that their secret, become common, should be employed to produce an immense increase of the precious metals, which must then have lost their value, and have ceased to be the medium of commerce among mankind. The reader may see, in a curious work by Dom Pernetty, entitled "Les Fables Egyptiennes et Grecques," 3 vols. 8vo., including the "Dictionnaire Mytho-hermetique," how far human sagacity may be extended, to find an explanation of such fables. But every thing may be explained in the same manner. We have heard of an adept, in the Faubourg Saint Marceau, who, being pursuaded that the whole Roman history was a fiction, intended to give a chemical explanation of it, which would serve as a supplement to the Fables Egyptiennes et Grecques. We have even heard that the history of the combat of the Horatii and the Curiatii was explained in it, with an appearance of truth, capable of making us doubt whether that famous circumstance in the Roman history ever really took place.

PRINCIPLES OF CRYSTALLIZATION

Crystals occur very frequently in the mineral kingdom, and have long attracted attention on account of their great beauty and regularity. By far the greater number of the salts likewise assume a crystalline form; and as these substances are mostly soluble in water, we have it in our power to give the regular shape of crystals in some measure at pleasure. It has long been observed by chemists and mineralogists, that there is a particular form which every individual substance always affects when it crystallizes: this indeed is considered as one of the best marks for distinguishing one substance from another. Thus, common salt is observed to assume the shape of a cube, and alum that of an octahedron, consisting of two four-sided pyramids, applied base to base. Saltpetre affects the form of a six-sided prism; and sulphate of magnesia that of a four-sided prism, whilst carbonate of lime is often found in the state of a rhomboid. Not that every individual substance always uniformly crystallizes in the same form; for this is liable to considerable variations from accidental circumstances, but there are a certain number of forms peculiar to every substance, and the crystal of that substance, in every case, adopts one or other of these forms, and no other; and thus common salt, when crystallized, has always either the figure of a cube, or octahedron, or some figure reducible to these.

To explain the cause of regular figures is a difficult task. Newton remarked, that the particles of bodies, while in a state of solution, are arranged in the solvent in regular order, and at regular distances; the consequence of which must be, that when the force of cohesion becomes sufficiently strong to separate them from the solvent, they will naturally combine in groups, composed of those particles which are nearest to each other. Now all the particles of the same body must be supposed to have the same figure; and the combination of a determinate number of similar bodies must produce similar figures. Hauy has made it exceedingly probable that these integrant particles always combine in the same body in the same way; that is to say, that the same faces, or the same edges, always attach themselves together; but that these differ in different crystals. This can scarcely be accounted for, without supposing that the particles of bodies are endowed with a certain *polarity* which makes them attract one particle of another body, whilst they repel the other parts. This polarity will explain the regularity of crystallization, but it is itself inexplicable.

There are, however, some circumstances in the phenomena of crystallization, which Hauy's theory does not well explain, and his views of the primitive forms of crystallized bodies are not in every instance incontrovertibly established. Thus, a slice of *fluor spar*, obtained by making two successive and parallel sections, may be divided into acute rhomboids: but these are not the primitive forms of the spar, because by the removal of a tetrahedron from each extremity of the rhomboid, an octahedron is obtained. As the whole mass, then, of the spar may be divided into tetrahedra and octahedra, it may be doubted which of these forms is to be considered as the primitive one, especially as neither of them can fill a given space without leaving vacuities, nor can they produce any arrangement sufficiently stable to form the basis of a permanent crystal.

Dr. Wollaston has given an exposition of another view of crystallization, (Philosoph. Transact. 1813.) He has proposed, that the primitive particles of bodies should be considered as spheres, which, by mutual attraction, have assumed that arrangement which brings them as near as possible to each other. When a number of similar balls are pressed together in the same plane, they form equilateral triangles with each other; and if balls so placed were cemented together, and afterwards broken asunder, the straight lines in which they would be disposed to separate, would form angles of 60° with each other. A single ball placed on this stratum would touch three of the lower balls, and the planes touching their surfaces would then include a regular tetrahedron. A square of four balls, with a single ball resting on the centre of each surface, would form an octahedron; and on applying two other balls at opposite sides of this octahedron, the group will represent the acute rhomboid. By this view, which is highly ingenious, the difficulty of the primitive form of fluor spar, above alluded to, is obviated. By oblate and oblong spheroids other forms may be assumed.

Sir Richard Phillips, in treating on cohesive attraction, says:—The experiments of Mr. Daniell, of M. Hauy, M. Link, and others, prove incontestibly, that all solids are varieties of crystallized forms; while it requires a very slight exertion of intellect to perceive that crystallized forms are necessary consequences of atoms being packed together by the action of the atoms of any elastic medium in which they are immersed. The powers of the latter are varied only by the variable form of the atoms which are its patients during the process of evaporation and reduction of bulk. The patient atoms, therefore, are packed as it were by the incessant activity of the elastic or fluid medium in which the process takes place; and they are dovetailed, or bound together by the atoms in other forms, which mingle during the process, thereby producing united crystals, which crystals constitute what we call solids, whose density, impenetrability, and resistance of foreign action or motion, are varied according to the original form of their atoms. Atomic forms, and the relative action of other circumjacent atoms are, therefore, the sole causes of all those phenomena of cohesion in bodies.

The principles on which crystallization depends, are concisely given by Chaptal, as follows:—

A body does not crystallize, unless, by a previous division, the cohesion is broken, and the particles are enabled fully and freely to exercise their reciprocal affinities.

This division may be effected by solution; the solution is operated in water for salts; in caloric for minerals; and in alcohol for resins and certain oils.

When a body is dissolved in one or the other of these fluids, the re-union of the particles dissolved is effected by evaporation, or by lowering the temperature of the liquid.

In those cases in which the solution is performed by water or alcohol, evaporate till small crystals are formed at the surface, or on the sides; then suspend the operation, and as the liquid cools, a great quantity of salt in crystals will be precipitated. By evaporating the liquid which remains, after removing the crystals on the top, you may obtain a second quantity of crystals, and extract all the liquid from the salt by successive operations. But if the dissolution is effected by caloric alone, as in metallic fusions, and those of sulphur and phosphorus, other precautions are necessary to decide the crystallization. If you suffer a melted metal to cool, it will not fail to appear again, in consequence of the refrigeration, in its primitive form; exhibiting at the same time some confused traces, or imperfect lineaments of crystallization, such as are observed in antimony and zinc. But if at the moment when the melted metal begins to harden, you pierce the crust, and let out the metallic liquid contained within, the vacancy will be lined with regular crystals, which almost always present the cubic or octahedral form. Hence we may infer, that the metal in a mass is in reality an aggregation of crystals, and that the only method of giving it the requisite cohesion and ductility, is to beat it with the hammer, and to *weld* it.

From what has been said concerning crystallization effected by evaporation and refrigeration, we may conclude, that, after having saturated a boiling liquid with any saline substance whatever, nothing more is necessary to obtain a deposit of crystals than to let it cool. We shall easily comprehend all these phenomena, if we consider that there are then two liquids acting upon the salt, (water and caloric;) by taking away one of them, we cannot fail of having the whole of the salt, which it held in solution, for a precipitate.

When the evaporation of the solvent proceeds slowly, the crystallization is always more regular; the particles then unite and arrange themselves by virtue of their affinities; but, on the contrary, when the evaporation is rapid, the particles are precipitated on each other, and there is nothing but confusion in their assemblage.

The slowness of the evaporation not only determines the regularity of the forms, but likewise contributes to give volumn to the crystals. This we observe daily in the saline solutions which we leave in a corner of our laboratories: it is demonstrated too by all the operations of nature, which forms in time, and by insensible evaporation, saline and stony crystals, which it is impossible for us to imitate, because it is not in our power to cause ages to enter as elements into our operations.

Rest is equally necessary for the liquid, in order to obtain forms of great regularity; uninterrupted agitation prevents all symmetrical arrangement; it precipitates the crystals as fast as they are formed, and you obtain nothing, if I may so express myself, but the integral particles of crystals.

In the arts we avail ourselves of the disturbance produced by agitation in liquids to procure crystals of extreme fineness. It is by this method that we precipitate, in very small and delicate needles, the crystals of sulphate of soda, those of nitrate of potass, &c.

It frequently happens, that a solution, though complete, refuses to crystallize; in this case a slight agitation of the vessel sometimes decides the crystallization. Fahrenheit observed, that, in this circumstance, heat escaped at the moment of agitation, which seems to prove that the caloric was interposed between the particles, and that nothing but the slightest motion was wanting to disengage it.

A crystal formed in water always retains a more or less considerable portion of the liquid, and this is called the *water of crystallization.*

The only cause of solution is, that the affinity of the liquid overcomes the cohesion which connects the particles of the salt; but in proportion as the mass of the liquid diminishes by evaporation, its affinity of mass decreases, and that of the particles of the body dissolved increases, since they begin to combine with each other. There must, consequently, be a moment at which the affinity of the salt overpowers that of the liquid; and from this moment the salt which forms itself into crystals must retain a portion of it. This water of crystallization enters as a principle into the combination, since that liquid cannot be discovered either by the eye, or by the touch, or by hygrometrical tests.

This water of crystallization contributes to give to the crystal its form, transparency, and cohesion. When it is disengaged by heat, these three characters almost always disappear. If, for example, you expose to heat a transparent crystal of sulphate of lime, you will instantly perceive the water to become volatilized and dissipated in a vapour; the crystal will lose its transparency, and be rendered friable and pulverulent.

Simple substances, such as metals, certain earths, sulphur, phosphorus, resins, and, in general, all such bodies as are simple, and not soluble in water, crystallize without retaining a sensible quantity of their solvent. But compound substances require to be dissolved in a liquid, that they may there acquire the portion necessary for the formation of their crystals.

MEDICAL RECEIPTS, &c.

Dixon's Antibilious Pills. — A nostrum composed of equal parts of aloës, scammony, rhubarb, and a little potassio-tartrate of antimony made up with Castile soap, and of course, a powerful cathartic, and deobstruent.

Dutch Drops.—A nostrum obtained by distilling oil of turpentine in a glass retort till a red balsam remains, which has also been called Balsam of Turpentine. Or by distilling resin till a thick red oil comes over. Or by dissolving 4 drams of flower of sulphur in 8 ounces of oil of turpentine.

Edinburgh Ointment, for itch, and tetter, is prepared with lard, white hellebore, and hydrochlorate of ammonia.

Fincham's Purifying and Disinfecting Liquid.—A solution of chloride of lime, requiring to be diluted for use with 40 parts of water.

Flash.—A preparation sold by brewers' druggists, to color brandy and rum, and to give them fictitious strength. It is prepared by making an extract of cayenne pepper or capsicum, and adding to it burnt sugar.

Ford's Balsam of Horehound is a cough nostrum, of which opium is the basis, being composed of equal parts of horehound and liquorice root, infused in water, strained, and a double portion of spirit added to nine pints, to which liquor add 7 drams of pure opium, 1 ounce of dried squills, 6 drams of benzoin, 9 drams of camphor, 8 drams of aniseseed, 1 ¾ pound of honey; digest and strain.

Fothergill's Pills.—A purgative nostrum, made with equal proportions of aloës, scammony, colocynth, oxide of antimony, and aromatic essences.

Friar's Balsam, Compound Tincture of Benzoin, Jesuit's Drops, Wade's Drops.—Take 2½ ounces of benzoin, 1½ ounce of storax strained, 10 drams of balsam of Tolu, 5 drams of aloës, and 2 pints of rectified spirit; digest fourteen days, and filter.—It was long celebrated as a styptic for the speedy cure of fresh wounds, cuts, &c.; but nothing could be more improper, as it is stimulant and irritating.

French Red, or Rouge, for the toilette. Take 1 ounce of genuine carmine, light in weight and strong in color, mix it with very finely-sifted starch powder, according to the shade required, and temper the color by the eye, which will be assisted by laying the powder on sheets of black paper.

German Paste, for cage birds, is prepared by beating together 2 pounds of pease flour, 1 pound of blanched sweet almonds, 3 ounces of fresh butter, and adding the yolks of two fresh eggs, and a little honey and saffron; then heat the mass gently, and pass it through a sieve, to form it into grains. If properly made it will keep good for half a year.

Gilbert's Antiscorbutic Drops. — A disguised preparation of bichloride of mercury.

Godbold's Vegetable Balsam.—A nostrum composed of oxymel, with some coloring matter and perfume to disguise it. The specification of Godbold's patent, however, directs separate syrups to be made of 42 different herbs, many of them poisonous, and then to be mixed with four different gums, vinegar, oil of cinnamon, &c., and kept three years before it is administered !!! By a late trial it appears that the proprietor's profits have fallen from 3,000*l.* to 50*l.* per annum.

Godfrey's Cordial.—A popular nostrum, the basis of which is opium. Infuse 9 ounces of sassafras, 1 ounce each of caraway, coriander, and aniseseeds, in 6 pints of water, simmer till reduced to 4 pints, add 6 pounds of treacle, or coarse sugar, and boil for a few minutes. When cold, add 3 ounces of tincture of opium or laudanum.

Godfrey's Smelling Salts.—A nostrum prepared by re-subliming sesqui-carbonate of ammonia, with carbonate of potass and alcohol to moisten it, which forms carbonate of ammonia, of a very pungent odour.

Gregory's Powder.—Made with equal parts of ginger, rhubarb, and calcined magnesia. It is a good stomachic in doses of 1 scruple or more.

Grindle's Cough Drops are a tincture of opium, prepared with rectified spirit. A very unsafe nostrum.

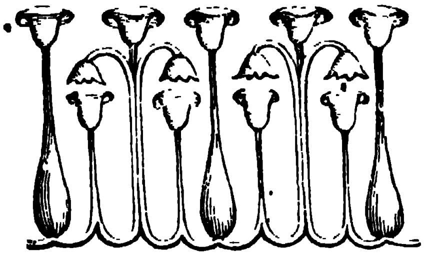
Gum Paste for Comfits.— Soak an ounce of gum tragacanth in half a pint of water, stirring it frequently, till quite dissolved, which it will be in 24 hours, squeeze it through a coarse cloth by twisting, put it into a mortar, and add four ounces of treble-refined sugar, work it well till quite white, put it in a glazed earthen pan, with a wet cloth over it; when wanted, take some of this paste, work, and knead in it fine sifted sugar, till it becomes soft without sticking to the fingers. When scented or colored, the aromatic materials are worked in.

EGYPTIAN ARCHITECTURE.

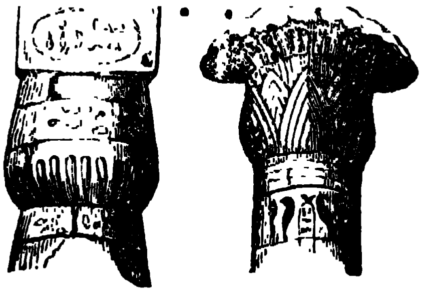
EGYPTIAN ARCHITECTURE.

In a work of the nature of a general magazine it is impossible to treat effectively of so extensive a subject as architecture, without engrossing too much space, and disappointing those of our friends who look for far different matter. We have, therefore, long hesitated whether to introduce the subject, and are still in doubt, if right, to pursue the subject through the Greek orders. Whether we do so or not, the noble and gigantic masses of masonry, raised by the ancient Copts or Egyptians, during the time of the Pharoahs, with all their rude yet splendid ornaments, cannot but be interesting, especially upon reflection, that with, perhaps, the exception of the cavern temples of India, of the times of which we have no account, the structures of Nubia, of Thebes and Memphis, are the most ancient records of human strength, skill, and taste, and those to which even the refined Greeks themselves owed their first ideas of architectural grandeur and imposing outline.

Well may the traveller of our day be astonished at the magnificence of the vast structures of ancient Egypt; its huge pyramids and proud tombs, which have long outlived the memory of the mighty kings whose ashes they contain; granite temples, as extensive as towns, which inclose in their courts, or support upon their roofs, villages of the present inhabitants; obelisks covered with hieroglyphics; colossal statues; long avenues of sphinxes, &c.; yet the art of building among them consisted of but few principles; for they did not seem to understand the use of the arch, all the apertures of their walls were covered with a single block of solid stone. Their domes or vaulted chambers (as in the great pyramid) were formed of stones, in horizontal courses, projecting equally over each other, like inverted flights of steps. The roofs of some of their temples are indeed arch-shaped, but these are only excavations out of the solid rock. Their walls were built of stones of enormous size, without cement. The removal and placing of these huge materials would, even at this day, almost bid defiance to the boldest and best constituted of our mechanical inventions, though conducted with all the science of modern times. The stones of their edifices are for the most part jointed and squared with the greatest accuracy; the hieroglyphic carvings with which their walls and ceilings are charged, are all recessed, but projecting in relief from the bottoms or backs of the recesses. The forms of Egyptian temples and gates are generally truncated pyramids, crowned with a cove or large hollow moulding, and fillet above.—But the cut, illustrative of the present subject, will give, perhaps, a better idea to the general reader of the details of Egyptian architecture than any verbal description. In the foreground of the right of the cut is a superb column, taken from the ruins of Dendera, or *Tentyris*. It will be seen how much labor has been expended upon a single column, yet the interior of a temple might be called a forest of columns, so numerous were they. The abacus (the capping stone at the top) is very peculiar, being nearly a cube in shape; it is elaborately carved with fillets and scrolls, and crowned with the winged globe, the emblem of eternity. The capital is four sided, each side bearing the face of Isis, the presiding deity of the temple. The shaft of the column is also richly carved in compartments of hieroglyphics, of reeded work, and towards the base, of the favorite lotus ornament, the emblem of beauty, and of the Nile,—in truth a national flower, as the rose is of England, and the lily of France. The large, purple, fragrant water lily called the lotus, may well be the pride of the Egyptians, and if their representations of it have not an English artist's taste, they at least show that these people could appreciate, if not express the beauty of their votive flower. The following is a more accurate detail of the lotus as an architectural ornament:—



It must not be thought that all the columns of their buildings are formed upon one model, like those of one of the Grecian orders. In truth they vary both in proportion and ornament. The shaft is often plain, more frequently reeded, or with round projecting ribs along it, and occasionally fluted. The abacus is often thin and inconspicuous, sometimes a flat sculptured block. The capital is even yet more varied—a fine bell shape is extremely common, covered either with leaves or with hieroglyphics. The following examples, from the temple of Carnac, may illustrate this observation.



Immediately under the column in the foreground is a lion sphinx, for the sphinxes of Egypt were various in character, sometimes representing the lion simply, occasionally uniting the brute and the human forms; and at other times being compounded of different animals, or monstrous altogether. They were placed in parallel rows, forming avenues of great length, and constituting, together with the colossi and the obelisks, the chief external appendages of the Egyptian temple. In the left hand of the cut you see one of these obelisks. It is the representation of one of the celebrated ones at Luxor, covered with hieroglyphics, and which was brought to, and is now erected in the French capital. Although the baseless obelisk be not in its effect a striking object, when viewed in conjunction with a large mass of buildings, it has paramount claims, when regarded as a *single stone*, and considered with reference to the labor and great mechanical skill, which must have been employed in detaching it from its native quarry, in transferring it to its destined basement, and in raising it to its vertical position.

At the back of the obelisk is a building composed of twin masses, rising on each side of the central door, which may be received as the established model of the gate that formed the entrance to any Egyptian buildings of considerable extent; and which from its superior loftiness was by far the most prominent and imposing feature of the temple's exterior. The most curious circumstance respecting it is the duplicate character, shown in the twin moles or towers, (to which we have already alluded,) the entrance being between them, so as to leave their individual solidity unimpaired. This gate is not merely to be considered as such, but it is also the usual form in which the front of the temple itself was constructed. Two immense piles of building tapering upwards, with a gate between them; the salient angles or arrises finished with a large round torus or bead; the summit crowned with a deep hollow entablature or cornice, finished with a fillet at top, and carved with longitudinal channels, often arranged, as in our figure, like the Grecian trigylph, constituted the characteristic form of outline and proportion; while the whole was oftentimes completely covered with hieroglyphics, and these painted with various colors, so vivid and imperishable that they remain fresh even in our day, and in the first ages of their construction and finish must have been monuments equally of taste and labor; and showing, in their contour and majesty, one of the greatest charms and requisites of architecture, *simplicity*.

ORIGIN OF SPRINGS AND FOUNTAINS.

It would appear that the origin of fountains and springs ought not to have occasioned such a diversity of opinions, as has, for some time, prevailed among philosophers. An attentive consideration of these phenomena is sufficient to show that the origin of them is entirely owing to the rains which continually moisten the surface of the globe, and which, running over beds of earth, capable of preventing them from penetrating deeper, at length force a passage to places which are lower. Every person, indeed, must have observed, that the greater part of springs decrease in a considerable degree, when a long drought has prevailed; that some of them absolutely dry up when this drought continues too long; that when the surface of the earth has been moistened with snow or rain, they are renewed; and that they increase almost in the same progression as the waters become more abundant.

Some philosophers, however, have ascribed the origin of fountains to a sublimation of the waters of the sea, which, flowing into the bowels of the earth, rise up in vapor, in the fissures of the rocks, and thence trickle down into cavities and reservoirs prepared by nature, from which they make their way to the surface. Some have even gone so far as to imagine them a sort of subterranean alembics.

But these conjectures are entirely void of foundation. If the water of the sea produced fountains in this manner, it would long ago have choaked up, with its salt, the subterranean conduits through which it is supposed to pass. Besides, the connection which is observed between the abundance of rain, and that of the water of the greater part of fountains, would not subsist; as the internal distillation would take place whether it rained or not. It is to be observed, also, that the water of springs always distils from *above* beds of clay, and not from *below* them; but as these beds intercept the passage of vapors and water, the latter must necessarily come from above them. A sure method of destroying a spring, is to pierce this bed; but if the water came from below, a contrary effect would be produced.

What induced philosophers to have recourse to a cause so remote, and so false, no doubt was their imagining that rain water was not sufficient to feed all the springs and rivers. But they were certainly in an error; for instead of rain water being too small in quantity to answer that purpose, it seems rather difficult to conceive in what manner it is expended. This will be proved by the following calculation of Mariotte.

This author observes that, according to experiments which have been made, there falls annually on the surface of the earth about 19 inches of water. But to render his calculation still more convincing, he supposes only 15, which makes per square toise 45 cubic feet, and per square league of 2300 toises in each direction, 238050000 cubic feet.

But the rivers and springs which feed the Seine, before it arrives at the Pont-Royal at Paris, comprehend an extent of territory, about 60 leagues in length, and 50 in breadth, which makes 3000 leagues of superficial content; by which, if 238050000 be multiplied, we shall have for product 714150000000, for the cubic feet of water, which falls, at the lowest estimation, on the above extent of territory.

Let us now examine the quantity of water annually furnished by the Seine. This river, above the Pont-Royal, when at its mean height, is 400 feet in breadth, and 5 in depth. The velocity of the water, when the river is in this state, may be estimated at 100 feet per minute, taking a mean between the velocity at the surface and that at the bottom. If the product of 400 feet in breadth, by 5 in depth, or 2000 square feet, be multiplied by 100 feet, we shall have 200000 cubic feet, for the quantity of water which passes in a minute through that section of the Seine, above the Pont-Royal. The quantity then in an hour will be 12000000; in 24 hours, 288000000; and in a year, 105120000000 cubic feet. But this is not the seventh part of the water which, as above seen, falls on the extent of country that supplies the Seine.

But how shall we dispose of the remainder of this water? The answer is easy: the rivers, rivulets, and ponds, lose a considerable quantity of water by evaporation; and a prodigious quantity is employed for the nutrition of plants.

Mariotte makes a calculation also of the water which ought to be furnished naturally by a spring that issues a little below the summit of Montmartre, and which is fed by an extent of ground 300 toises in length, and 100 in breadth; making a surface of 30000 square toises. At the rate of 18 inches for the annual quantity of rain, the quantity which falls on that extent will amount to 1620000 cubic feet. But a considerable part of this water, perhaps three-fourths, immediately runs off: so that no more than 405000 forces its way through the earth and sandy soil, till it meets with a bed of clay at the depth of two or three feet, from which it flows to the mouth of the fountain, and feeds it. If 405000 therefore be divided by 365, the quotient will be 1100 cubic feet of water, which it ought to furnish daily, or about 38500 French pints; which makes about 1600 pints per hour, or 27 pints per minute. Such is nearly the produce of this spring.

An objection, founded on an experiment of M. de la Hire, described in the memoirs of the "Academy of Sciences," for the year 1703, is commonly made to this idea respecting the origin of springs. This philosopher having caused a pit to be dug in a field, to the depth of 2 feet, found no traces of moisture: from which some conclude that the rain water flows only over the surface, and does not, in any manner, contribute to the origin of springs.

But this experiment is of no weight, as it is contradicted by a thousand contrary instances. Every one knows that water, in various places, oozes from the roofs of caverns and subterranean passages: it is this water which, after penetrating the earth, and flowing between the joints of stones, produces stalactites, and other stony concretions. It is, therefore, false that rain water never penetrates beyond the depth of a few feet. The fact, observed by M. de la Hire, was a particular case, from which it was wrong to deduce a general consequence.

It is objected also, that water is sometimes collected at heights at which it is impossible that the rain water could give birth to a spring. To this it may be replied, that if the ground, where these collections of water exist, be examined, it will always be found that they are produced by rain or melted snow; that these places on the summits of mountains are only a kind of funnels, which collect the waters of some neighbouring plain, continually maintained by the rain or snow, assisted by the small evaporation which takes place, in consequence of the rarity of the air. It is, therefore, evident to every rational mind, that the origin of springs and fountains can be ascribed to no other cause, than the rain water and snow which have been collected.

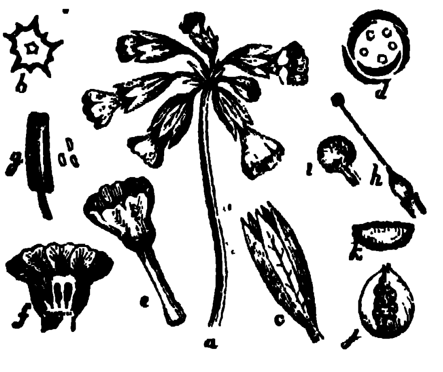
BOTANICAL NOTICES.

REPRODUCTIVE ORGANS OF PLANTS.

The reproductive organs of phænogamous, or flowering plants, are the flowers and the fruit, because these parts are of necessity in the preparation, the maturing, and defending the seed.

Both the flower and the fruit consist of several parts: for example, in the common primrose there is outside of all a green cup, which incloses the rest of the flower—this is *the calyx*. Within the calyx is a colored leafy part, called *the corolla*. These two parts together are the *floral envelopes*. Still more inwards are a number of colored threads, with a knob at the end of each—these are *stamens*. Innermost of all is a green swelled-out body, called a *pointal* or *pistil*, which is either the young seed vessel or leads to it; and the part of the stalk upon which the whole of these organs are placed is the *receptacle*. The manner in which flowers grow together or upon the stalk which bears them, is called their *inflorescence*, and the folding up of the different parts of the flower before opening is called their *æstivation*.

The following cut will enable the student clearly to understand the nature, position, and usual character of the reproductive organs, as exemplified in the cowslip :—

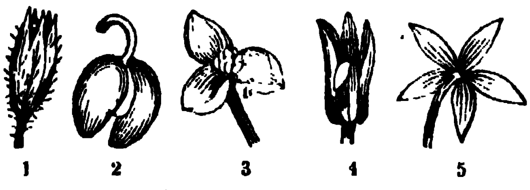


A. Shows the inflorescence or mode of flowering. B. The æstivation or folding up of the calyx C. The calyx removed. D. The æstivation of the corolla E. The corolla removed. F. The corolla opened to show the five stamens G. A stamen magnified, with some grains of pollen by the side of it. H. The pistil. I. The stigma or top of the style, magnified. J The seed vessel cut open lengthwise. K. A seed cut open to show the embryo lying across it.

The re-productive organs vary in shape, relative size, and method of attachment to each other, no less than do the roots, leaves, &c. Sometimes one or other of them is deficient—in different cases more than one: thus a flower may want calyx or corolla, or both, when it would be called *incomplete*, or it may have all these organs, and be *complete*. Occasionally one part is redundant, or of unnatural form or size, in which case the flowers become *monstrous*. Thus cultivation, injury, excess of food, and many other causes, make such great alterations in the structure, and still more often in the *habit* or appearance of a plant, that it is sometimes scarcely possible to recognize the altered form. However greatly variations of this kind may contribute to the beauty of the flower, or the utility of the fruit, yet by the botanist such changlings must be disregarded as unnatural. The hen and chicken daisy, the hose-in-hose polyanthus, and all double flowers, are in this condition. Even "the queen of our gardens," the elegant rose itself, is to be considered but as a vegetable monster, uncourteous as the term may seem, because culture has increased its moss, multiplied its petals, brightened its colors, and it therefore no longer bears in our gardens those simple flowers with which nature invested it.

Calyx.—The outer part of every complete flower bears the name of calyx, whatever may be its size, form, or color. The general use of this organ is to defend the more delicate parts of the flower from injury, when in their young and unfolded state.

A calyx consists, in its usual state, of a leafy green cup, more or less cut and divided. The different parts or leaves of which it consists are called sepals, and it often takes its name from the number of these sepals. Thus, in the primrose it is *monosepalous*, (1,)—that is, one-leaved. In the poppy, *disepalous*, (2,)—or consisting of two leaves. It may also consist of three sepals, (3,) as in the pilewort. Four sepals, as in the cabbage, (4.) It is 5, 6, 8, 10, sepaled in other plants, when its name would be appropriate to these numbers

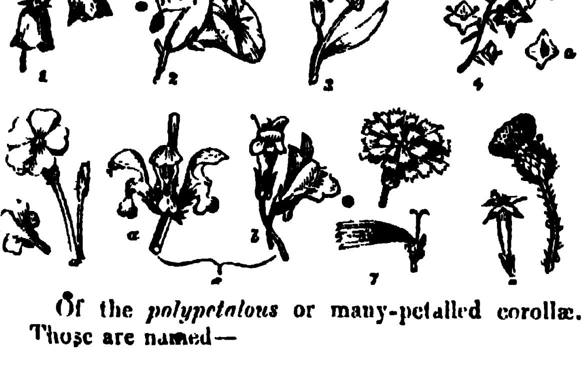


It is tubular, lipped, puffed out, ribbed, spurred, notched, or entire. If, it fall off when the flower opens, it is *fugacious*—if it drop with the rest of the flower, it is *caducous*—if it remain until the fruit is ripe, it is *persistent*. When situated above the fruit, as in the rose, it is called *superior*, (1,)—when under the fruit, as in the mallow, it is *inferior*, (2.)

Although persistent calyces remain after the time of flowering, it is generally in a dry and withered state, particularly in those which are superior; and when inferior, although they retain their green color and living texture longer, yet it is not often that they continue growing after that period. In some plants, however, it is different, for the calyx increases during all the time of the fruit ripening—in illustration of which the curiously-enlarged calyces of the *nicandra physalodes*, and the bag-shaped calyx of the winter cherry may be referred to, especially as they add so greatly to the beauty of the fruit of these and similar plants. The calyx of the henbane is another of a most beautiful and regular form. It is also to be observed, that the calyx is often colored, as in the fuschia it is of a most beautiful scarlet. When a flower has but one envelope to its stamens, we must consider that a calyx, whatever may be its color or form. The noble lily, the gaudy tulip, and the golden crocus, owe their beauty to their colored calyces; unless indeed, as some botanists have done, we consider them as *perianths*, that is, a covering, which partakes of the position of a calyx and the character of a corolla.

Corolla.—The corolla is that part of the flower which is next within the calyx, and between that and the stamens. It is generally the most brightly-colored of the floral envelopes; thus, the red leaves of the rose, the yellow of the buttercup, and the blue of the bell flower, constitute the various corollæ of those plants. A corolla may consist of only one leaf or *petal*, as it is more properly called, when the form of this gives it an appropriate name; or it may be of several petals, when their arrangement and thickness serve as marks of distinction. When the various petals or divisions of a corolla are alike, it is said to be *regular*—if not, *irregular*.

Of *monopetalous* or one-petalled corollæ, the lower part is called the *tube*—the upper expanded part, the *limb*, and where these join one another, the *mouth* or *throat*. They are either *campanulate* or *bell-shaped*, (1,) as in the blue-bell—*funnel-shaped*, (2,) as in the bell-bind—*trumpet-shaped*, (3,) as in the tobacco flower—*rotate* or *wheel-shaped*, (4,) this is flat and without a tube, as in the speedwell—*salver-shaped*, (5,) or flat, with a tube, as in the primrose—*lipped* or deeply divided into two parts at the limb: this variety may be either *ringen*[illegible] gaping, (6*a*,) where the two lips stand widely open, as in the white nettle—or *personate*, (6*b*,) when they close up like a mouth, as in the snap dragon. The corolla is *strap-shaped*, (7,) in the dandelion, and *tubular*, (8,) in the thistle.

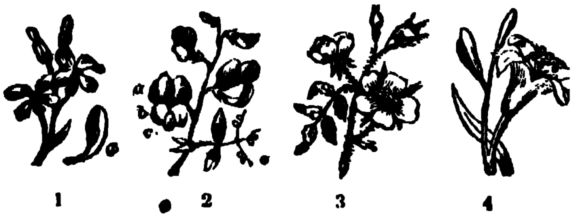


Of the *polypetalous* or many-petalled corollæ. Those are named—

Cruciform, (1,) which have four petals arranged in the form of a cross, as in all the plants of the fifteenth class, such as the wall-flower, stock cabbage, &c. Here the outer part of the petal is called the *margin*, and that part covered by the calyx is the *claw*—(*a*, a petal separated.)

Papilionaceous, (2,) when five petals are arranged so as to look something like a butterfly, (in Latin, papilio,) as in the sweet pea flower. The upper petal, which covers over the rest, is called the *vexillum* or *standard*, (*a*,)—the two side petals are *alæ* or wings, (*b*,)—and the two lower and inner ones, when joined together, form what goes by the name of the *carina* or *keel*, (*c*.)

A corolla is *rosaceous*, (3,) when the petals are thin, like those of the rose—and *liliaceous*, (4,) when the petals are thick, like those of the lily.



The use of the corolla, apparently, is to defend the inner parts of the flower from some injuries they might sustain from wind or damp, and so to collect and concentrate the sun's light and heat upon those parts as to ripen them, and aid in the more rapid exercise of their functions.

Nectary.—There is often found attached to the corolla, or situated near it, variously shaped and colored parts, not contributing to the regular formation of a flower, nor yet apparently necessary to its structure. These are the nectaries, parts so called because of the honey which some of them secrete—the use of which sweet fluid seems to be, that the insects being attracted to the flower, and fluttering about within it, may aid in distributing the pollen from the stamens to the stigma—a process which is neccssary to the well-being of the future seed.

Every flower does not contain a nectary, not even all those which secrete honey, as, for example, the corolla tube of the white nettle is sweet, but has no particular organ to collect the honey within it. So also, many parts are for convenience considered nectaries, which have no such use. In fact, every part of a flower, which is neither calyx, corolla, stamen, nor pointal, is classed under this general term. The nectary, therefore, has the same meaning when applied to flowers, as the word fulcrum has to the preservative organs.

(To be continued.)

LIGHT.

(Resumed from page 143, and concluded.)

Corpuscular Theory of Light.—Sir John Herschel, in his admirable *Essay on Light* in the *Encyclopædia Metropolitana*, states the principles of the Newtonian or corpuscular theory as follows:—

1. "That light consists of particles of matter possessed of inertia, and endowed with attractive and repulsive forces, and projected or emitted from all luminous bodies with nearly the same velocity,—about 200,000 miles per second.

2. "That these particles differ from each other by the intensity of the attractive and repulsive forces which reside in them; and in their relations to the material world; and also in their actual masses, or inertia.

3. "That these particles, impinging on the retina, stimulate and excite vision; the particles whose inertia is greatest producing the sensation of red, those of the least inertia of violet, and those in which it is intermediate the intermediate colors.

4. "That the molecules of material bodies and those of light exert a mutual action on each other, which consists in attraction and repulsion, according to some law or function of the distance between them; that this law is such as to admit, perhaps, of several alternations of changes from repulsive to attractive force; but that when the distance is below a certain very small limit it is always attractive up to actual contact, and that beyond this limit resides at least one sphere of repulsion. This repulsive force is that which causes the reflection of light at the external surfaces of dense media; and the interior attraction that which produces the refraction and interior reflection of light.

5. "That these forces have different absolute values or intensities, not only for all different material bodies, but for every different species of the luminous molecules, being of a nature analagous to chemical affinities or electric attractions; and that hence arises the different refrangibilities of the rays of light.

6. "That the motion of a particle of light, under the influence of these forces and its own velocity, is regulated by the same mechanical laws which govern the motions of ordinary matter; and that therefore each particle describes a trajectory, capable of strict calculation as soon as the forces which act on it are assigned.

7. "That the distance between the molecules of material bodies is exceedingly small, in comparison with the extent of their spheres of attraction and repulsion on the particles of light.

8. "That the forces which produce the reflection and refraction of light are, nevertheless, absolutely insensible at all measureable or appreciable distances from the molecules which exert them.

9. "That every luminous molecule, during the whole of its progress through space, is continually passing through certain periodically recurring states, called by Newton fits of easy reflection and easy transmission, in virtue of which they are more disposed, when in the former states or phases of their periods, to obey the influence of the repulsive or reflective forces of the molecules of the repulsive or reflective forces of the molecules of a medium; and when in the latter, of the attractive."

Such are the postulates on which the corpuscular theory of light depends. Most of them may be admitted without difficulty; and they afford data for the application of mathematical reasoning to the phenomena, which may be investigated by the same sort of analysis with which mathematicians are already familiar in the theories of heat, capillary attraction, and molecular forces.

Undulatory Theory.—The principles of the undulatory theory are thus stated by Sir J. Herschel:—

1. "That an excessively rare, subtle, and elastic medium, or *ether*, fills all space, and pervades all material bodies, occupying the intervals between their molecules; and either by passing freely among them, or by its extreme rarity, offering no resistance to the motion of the earth, the planets, or comets, in their orbits, appreciable by the most delicate astronomical observations; and having inertia, but not gravity.

2. "That the molecules of the ether are susceptible of being set in motion by the agitation of the particles of ponderable matter; and that when any one is thus set in motion it communicates a similar motion to those adjacent to it, and thus the motion is propagated further and further in all directions, according to the same mechanical laws which regulate the propagations of undulations in other elastic media, as air, water, or solids, according to their respective constitutions.

3. "That in the interior of refracting media the ether exists in a state of less elasticity, compared with its density, than in vacuo (*i. e.* in space empty of all other matter); and that the more refractive the medium, the less, relatively speaking, is the elasticity of the ether in its interior.

4. "That vibrations communicated to the ether in free space are propagated through refractive media by means of the ether in their interior, but with a velocity corresponding to its inferior degree of elasticity.

5. "That when regular vibratory motions of a proper kind are propagated through the ether, and passing through our eyes, reach and agitate the nerves of our retina, they produce in us the sensation of light, in a manner bearing a more or less close analogy to that in which the vibrations of the air affect our auditory nerves with that of sound.

6. "That as, in the doctrine of sound, the *frequency* of the aërial pulses, or the number of excursions to and fro from the point of rest made by each molecule of the air, determines the pitch of note; so, in the theory of light, the frequency of the pulses, or number of impulses made on our nerves in a given time by the ethereal molecules next in contact with them, determines the *color* of the light: and that as the absolute extent of the motion to and fro of the particles of air determines the *loudness* of the sound, so the *amplitude* or extent of the excursions of the ethereal molecules from their points of rest determines the brightness or intensity of the light."

Whichever theory we adopt to explain the phonomena of light, we are led to conclusions which strike the mind with astonishment. According to the corpuscular theory the molecules of light are supposed to be endowed with attractive and repulsive forces, to have poles, to balance themselves about their centres of gravity, and to possess other physical properties which we can only ascribe to ponderable matter. In speaking of these properties it is difficult to divest one's self of the idea of sensible magnitude, or by any strain of the imagination to conceive that particles to which they belong can be so amazingly small as those of light demonstrably are. If a molecule of light weighed a single grain, its momentum (by reason of the enormous velocity with which it moves) would be such, that its effect would be equal to that of a cannon-ball of 150 lbs. projected with a velocity of 1000 feet per second. How inconceivably small must they therefore be when millions of molecules, collected by lenses or mirrors, have never been found to produce the slightest effect on the most delicate apparatus contrived expressly for the purpose of rendering their materiality sensible.

If the corpuscular theory astonishes us by the extreme minuteness and prodigious velocity of the luminous molecules, the numerical results deduced from the undulatory theory are not less overwhelming. The extreme smallness of amplitude of the vibrations, and the almost inconceivable but still measurable rapidity with which they succeed each other, were computed by Dr. Young.

On a cursory view, it must appear singular that two hypotheses, founded on assumptions so essentially different, should concur in affording the means of explaining so great a number of facts with equal precision and almost equal facility. This, however, is the case with respect to the corpuscular and undulatory theories of light, from both of which the mathematical laws to which the phenomena are subject may be deduced, though not in all cases with the same degree of facility. So far as the corpuscular doctrine is available for the purposes of deductive explanation, it possesses all the characteristics of a good theory. It supposes the operation of a force with which we are in some measure familiar. We are accustomed to contemplate the effects of attraction in the grand phenomena of astronomy; we perceive them at every instant in the downward tendency of all heavy bodies; and though they disappear in the small bodies of nature, they are reproduced in the phenomena of electricity, magnetism, capillary attraction, electricity, and various chemical actions, where they can be not only distinctly traced, but reduced to mathematical formulæ, and submitted to accurate calculation.—The undulatory hypothesis is not seized by the mind with the same facility; yet it also possesses some of the least equivocal characteristics of philosophical truth. No phenomenon has yet been discovered decidedly at variance with any of its principles. On the contrary, most of the phenomena follow from those principles with remarkable ease; and, in numerous instances, consequences deduced from the theory by a long and intricate analysis, and where no sagacity could possibly have divined the result, have been found to be accurately true when brought to the test of experiment. Hence this hypothesis begins to be generally adopted by philosophers, and, in recent times, by far the most illustrious names in the annals of optical discovery are included in the list of its supporters.

That the sensation of light is produced by the vibrations of an extremely rare and subtle fluid, is an idea that was maintained by Descartes, Hooke, and some others; but it is to Huyghens that the honor solely belongs of having reduced the hypothesis to a definite shape, and rendered it available to the purposes of mechanical explanation. Owing to the great success of Newton in applying the corpuscular theory to his splendid discoveries, the speculations of Huyghens were long neglected; indeed, the theory remained in the same state in which it was left by him till it was taken up by our countryman, the late Dr. Young. By a train of mechanical reasoning, which, in point of ingenuity, has seldom been equalled, Dr. Young was conducted to some very remarkable numerical relations among some of the apparently most dissimilar phenomena of optics, to the general laws of diffraction, and to the true principles of the coloration of crystallized substances. Malus, so late as 1810, made the important discovery of the polarization of light by reflection, and successfully explained the phenomenon by the hypothesis of an undulatory propagation. The theory subsequently received a great extension from the ingenious labors of Fresnel; and the still more recent researches of Arago, Poisson, Herschel, Airy, and others, have conferred on it so great a degree of probability that it may be almost regarded as ranking in the class of demonstrated truths. "It is a theory," says Herschel, "which, if not founded in nature, is certainly one of the happiest fiction that the genius of man has yet invented to group together natural phenomena, as well as the most fortunate in the support it has received from whole classes of new phenomena, which at their discovery seemed in irreconcileable opposition to it. It is, in fact, in all its applications and details, one succession of *felicities*, insomuch that we may almost be induced to say, if it be not true it deserves to be so."

Relations of Light and Heat.—Light and heat are so intimately related to each other, that philosophers have doubted whether they are identical principles, or merely coexistent in the luminous rays. They possess numerous properties in common; being reflected, refracted, and polarized according to the same optical laws, and even exhibit the same phenomena of interference. Most substances, during combustion, give out both light and heat; and all bodies, excepting the gases, when heated to a high temperature become incandescent. Nevertheless, there are many circumstances in which they appear to differ.

A thin plate of transparent glass interposed between the face and a blazing fire intercepts no sensible portion of the light, but most sensibly diminishes the heat. Light and heat are, therefore, not intercepted alike by the same substances. Heat is also combined in different degrees with the different rays of the solar spectrum. A very remarkable discovery on this subject was made by Sir William Herschel, which would seem to establish the independence of the heating and illuminating effects of the solar rays. Having placed thermometers in the several prismatic colors of the solar spectrum, he found the heating power of the rays gradually increased from the violet (where it was least) to the extreme red, and that the maximum temperature existed at some distance beyond the red, out of the visible part of the spectrum. The experiment was soon after repeated with great care by Berard, who confirmed Herschel's conclusions relatively to the augmentation of the calorific power from the violet to the red; but he found the maximum heat existed at the extremity of the red, and not beyond the spectrum. This discovery of the inequality of the heating power of the different rays led to the inquiry whether the chemical action, produced by light on certain bodies, was merely the effect of the heat accompanying it, or owing to some other cause. By a series of delicate experiments, Berard found that this action is not only independent of the heating power, but follows an entirely different law; its intensity being greatest in the violet ray, where the heating power is the least, and least in the red ray, where the heating power is greatest. We are thus led to the conclusion that the solar rays possess at least three distinct powers,—those of heating, illuminating, and effecting chemical combinations and decompositions; and these powers are distributed among the differently refrangible rays in such a manner as to show their complete independence of each other.

Light acts a very important part in the vegetable economy. The green color of plants and the hue of flowers entirely depend on it; and it is found even to influence the form of their leaves. Its effects in developing the forms of some of the lower classes of animals have also been proved by various experiments; and there are probably many other powers resident in the same wonderful agent of which we can at present form no adequate notion.

MEMORANDA.

Formation of Rocks.—Though several of the agencies which operated during the earliest eras in the physical history of our globe either now exert a comparatively diminished influence, or have ceased altogether, yet the general law of nature unquestionably continues the same, and rocks are in course of formation by various causes, and under diversified circumstances, at the present day. Not only do the coral formations continue in the southern ocean to produce reefs, islands, and by the connexion and increase of these, to form continents; but, in our own islands, accumulations of sand, mud, and shells, are producing fresh layers in the bed of the sea, and constituting fresh deposits, which add to the crust of our globe, and will form a subject of interest to the future inquirer into its history; but every river and every stream is in like manner converting its bed into rock, and the operation is often assisted by causes of an extraordinary and singular kind. A very remarkable instance of this nature was brought to light a few years since. During the unhappy and distracted reign of Edward II. several of the English barons took up arms against the monarch and his favorites, the Gavestones. One of their insurrections was headed by the Earl of Leicester, whose associate in the enterprise was the Earl of Lancaster, the latter nobleman taking charge of the military chest, and the paying the troops, &c. &c. While the insurgent army were crossing the river Dooe, in Derbyshire, in the night, they were attacked and routed by the king's troops;—and, in the confusion, the military chest, with its contents, was thrown into the stream, and sunk to the bottom. The Earl of Lancaster was shortly after beheaded (in March, 1322), and all trace of the treasure was lost sight of. After the lapse of half a thousand years, on some excavations being made a few years since for the purpose of deepening the bed of the river, masses of ferruginous breccia—that is, of pebbles, gravel, &c., cemented into rock by the rust of iron, were found, many of them containing coins of the period, silver pennies of Edward I., &c., evidently forming portions of the lost treasure. It would seem that the box containing the money had been bound or otherwise fitted with iron, and that the decomposition of the metal had produced a cement sufficient to convert these pebbles into rock. The circumstance is not altogether unique; and the efficiency of iron to produce such a result is perfectly well known; but the preservation of these coins by so remarkable a cause constitutes a highly remarkable and interesting fact. *British Queen.*

New Oxide of Iron.—This combination has been obtained by M. Fremy. It communicates a violet color to water, and possesses a powerful dyeing principle. It resembles manganese chameleon. It decomposes readily when boiled with an alkali or organic substance having an affinity for oxygen, and is converted into oxygen and sesqui-oxide of iron, of a yellow color. This combination is a perferrate of potash, which may be procured by calcining peroxide of potassium and peroxide of iron.—Fremy has shown that the appearance of a chameleon color is no proof of the presence of manganese, as it may be confounded with the new oxide of iron. Fremy forms this oxide by igniting a mixture of potash and peroxide of iron; a brown mass is the result, which, by digestion in water, gives a beautiful violet-red solution. This compound is very soluble in water. A large quantity of water decomposes it in the course of time. It becomes insoluble in very alkaline water, forming a brown precipitate, which readily dissolves in pure water, and affords a fine purple solution. It appears much less stable than manganate of potash. A temperature of 212° decomposes it immediately; all organic substances decompose it. It is consequently impossible to filter the solution. It is impossible to isolate this compound, for when the red solution is treated by an acid, when the potash is saturated, oxygen is disengaged, and peroxide of iron precipitated. If the acid is in excess, it dissolves the peroxide, and gives rise to the formation of peroxide salt of iron.

Glass Church-Bells are among modern wonders. One has just been cast in Sweden; its diameter is six feet, and its tone is said to be finer than any metal bell.—*Tyne Mercury.*

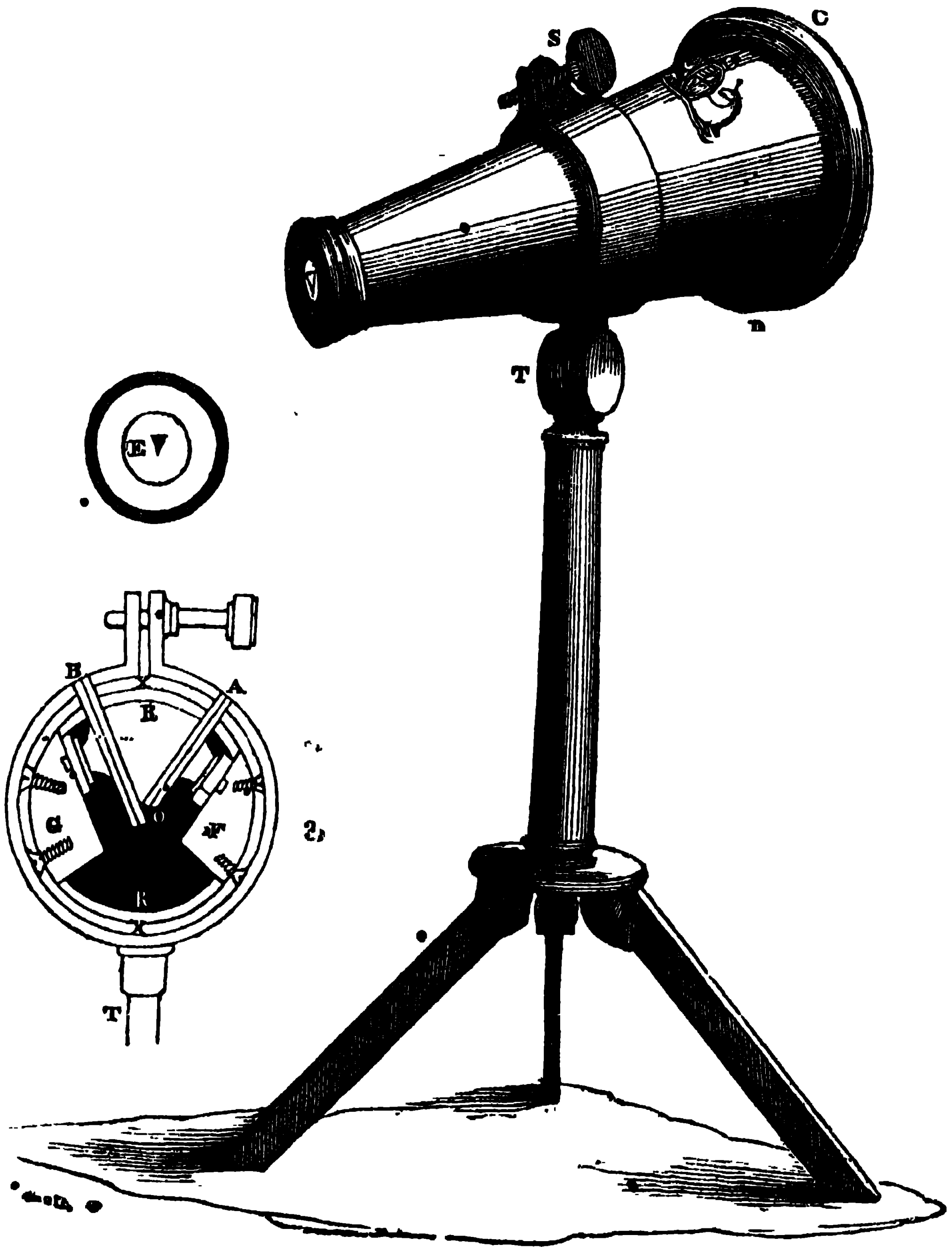
Use of Lime in Planting Trees.—A large plantation has, within the last two or three years, been formed in the neighbourhood of Inverness, without the loss of a single tree, and this has been achieved by a very simple process. It is merely putting a small quantity of lime in the hole with the plant; about four bushels of lime will suffice for an acre. It must be thoroughly mixed and incorporated with the mould before the plant is inserted. The effect of the lime is, to push on the growth of the plant in its first and most precarious stage. New fibres begin to form and ramify from the top root; and not only is the safety of the plant ensured, but its growth is advanced in double ratio.—*Inverness Courier.*

Kalorama.—Under this title an exhibition of a novel kind has been thrown open in Bond Street. It consists of landscapes on a large scale, and presenting trees, water, animals, human figures, and every variety of scenery; but instead of canvas and color, being composed of paper cut out with scissors, and by disposition and gumming together, made to represent all these features in a very effective manner. In some points the distances are managed by having the materials on different horizontal lines; in others, by painting the background. As objects of curiosity, these *Kaloramic* products deserve a visit.

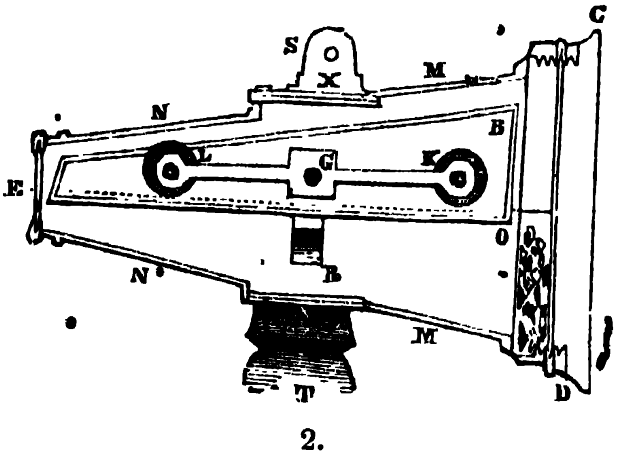
Music of Light.—Dr. Buchanan, of Kentucky, conceives that he has found some affinity between the different rays of light, as presented in a rainbow, and the notes of music. Following up this theory, real or imaginary, he proposes to furnish a concert for the eye; that is, that the eye should experience the same pleasure by an harmonic rise and fall of the different rays of light, as the ear does by the accordance of sweet sounds. How far this plan is practicable, is a thing resting on experiment. Something analogous to this may have given birth to the fable of Memnon's harp, which was said to have uttered delightful strains of melody when touched by the solar rays.

To Destroy Caterpillars.—A mode of destroying caterpillars has been discovered by accident. A piece of woollen rag had been blown by the wind into a currant-bush, and when taken out was found covered by these leaf-devouring insects. Pieces of woollen cloth were immediately placed on every bush in the garden, and next day the caterpillars had universally taken to them for shelter. In this way thousands were destroyed every morning.—*National Advertiser.*

Fig. 1.



BATE'S POLYANGULAR KALEIDOSCOPE.



2.

BATE'S POLYANGULAR KALEIDOSCOPE.

In the common kaleidoscopes, the reflecting planes are fixed in an invariable angle, which is some even aliquot part of 360°; and, therefore, though the forms or patterns which they create are literally infinite in number, yet they have all the same character, in so far as they are composed of as many pairs of direct and inverted images as half the number of times that the inclination of the reflectors is contained in 360°.

It is of the greatest importance, in the application of the kaleidoscope to the arts, to have it constructed in such a manner, that patterns composed of any number of pairs of direct and inverted images may be created and drawn. With this view, the instrument may be fitted up in various ways, with paper, cloth, and metallic joints, by means of which the angle can be varied at pleasure; but the most convenient method is shown in the polyangular kaleidoscope, the construction of which is as follows:—

The three figures, viz. 1, 2, 3, represent the polyangular kaleidoscope with metallic reflectors, as made by Mr. Bate, optician. Fig. 1 shows the complete instrument, when mounted upon a stand; fig. 2 is a section of it in the direction of its length; and fig. 3 is a transverse section of it through the line S T, fig. 2. The tube of this instrument is composed of two cones, M M, N N, fig. 2, connected together by a middle piece or ring R R, into which they are both screwed. These two cones inclose two highly-polished metallic reflectors A O, B O, fig. 3, only one of them, viz. B O E, being seen in fig. 2. One of these reflectors B O E, is fixed to the ring R R, by the intermediate piece K G L. The reflector is screwed to this piece by the adjustable screws K L; and the piece K G L is again fixed to the ring R R by two screws seen above and below G, in fig. 3. Hence the tube, consisting of the cones M M, N N, and the ring R R, are immoveably connected with the mirror B O E. The surface of the reflector B O E is adjusted by the screws at K and L, till it passes accurately through the axis of the cones and ring as seen in fig. 3. The other reflector A O, is fixed to an outer ring X X, by means of an intermediate piece, similar to K G L, the arm F of which, corresponding to G, passes through an annular space, or open arch, of more than 90°, cut out of the circumference of the inner ring R R. The arm F is fixed to the outer ring X X by two screws, seen above and below F, in fig. 3; and the reflector A O is fixed to the bar corresponding to K L, by similar screws, for the purpose of adjusting it.

The lower edge O E of the reflector B O E extends about the 15th of an inch below the axis of the cones, as represented by the dotted line in fig. 2; but the lower edge O E of the other reflector A O E, which is finely ground to an acute angle, forming a perfectly straight and smooth line, is placed exactly in the axis of the cones, so as just to touch a line in the reflector A O E, which coincides with the axis of the cones, and to form a juction with that line in every part of the two meeting planes. The very nice adjustments which are necessary to produce so exact a motion are effected by the screws corresponding to K and L.

If we now fix the outer ring X X into the ring of a stand S T, so as to be held fast, and turn the cones with the hand, we shall give motion to the reflector B O, so as to place it at any angle we please, from 0° to 90°; and, during its motion through this arch, the junction of the two reflectors must remain perfect, if the touching lines are adjusted, as we have described them, to the axis of motion, which must also be the axis of the cones and rings. If, on the contrary, we take away the stand, and, holding the instrument in the hand by either of the cones M, N, turn the ring R with the other, we shall give motion to its reflector A O, and produce a variation in the angle in the same manner as before; or the same effect may be produced by an endless screw working in teeth, cut upon the circumference of the outer ring X X

In order to enable the observer to set the reflectors at once to any even aliquot part of a circle, or so as to give any number of pairs of direct and inverted images, the most convenient of the even aliquot parts of the circle are engraven upon the ring X X; so that we have only to set the index to any of these parts, to No. 12 for example, and the reflectors will then be placed at an angle of 30°, and will form a circular field with *twelve* luminous sectors, or a star with *six* points, and, consequently, a pattern composed of *six* pairs of direct and inverted images.

As the length of the plates is only about five inches, it is necessary, excepting for persons very short-sighted, to have a convex lens placed at E. A brass ring, containing a plane glass, screws into the outer ring C D, when the instrument is not in use; and there is an object plate containing fragments of differently colored glass. This object plate consists of two plates of glass, one ground, and the other transparent, set in brass rims. The transparent one goes nearest the reflector, and the brass rim which contains it screws into the other, so as to inclose between them the colored fragments, and regular figures of colored and twisted glass. A loose ring surrounds this object plate;—and when this ring is screwed into the circular rim C D, the object plate can be turned round so as to produce a variety of patterns, without any risk of its being detached from the outer cone.

In applying this instrument to opaque objects, such as engravings, coins, gems, or fragments of colored glass laid upon a mirror, the aperture of the mirrors is laid directly over them, the large cone M M having been previously unscrewed, for the purpose of allowing the light to fall freely upon the objects. This property of the kaleidoscope is of great importance, as in every other form of the instrument, opaque objects must be held obliquely, and, therefore, at such a distance from the reflectors as must affect the symmetry of the pattern.

As the perfection of the figures depends on the reflectors being kept completely free of dust, particularly at the angles, where it naturally accumulates, the greatest facility is given by the preceding construction in keeping them clean. For this purpose, the large cone must be unscrewed; the reflectors having been previously closed, by turning the index to 60 on the ring. They are next to be opened to the utmost, and the dust may in general be removed by means of a fine point wrapped in clean and dry wash leather. If any dust, however, still adheres, the small screw in the side of the ring opposite to the index should be removed, and the smaller cone, N N, also unscrewed. By easing the supporting screws of either of the reflectors, their touching sides will separate, so as to allow a piece of dry wash leather to be drawn between them. When every particle of dust has been thus removed, the metals should be re-adjusted and closed before the cones are replaced; both of which should be screwed firmly into the ring R R.

As the axis of motion in the preceding construction is necessarily the axis of the cones and rings, the diameter of these cones and rings must every where be double the breadth of the reflectors.—From this cause, the tube, and consequently the object plate, are wide, and the instrument is, to a certain degree, unportable.

The advantages which the polyangular kaleidoscopes possess over all others, are—

1. That patterns of any number of sectors, from the simplest to the most complicated, can be easily obtained.

2. That the reflectors can be set, with the most perfect accuracy, to an even aliquot part of a circle.

3. That the reflectors can be, at any time, completely cleaned and freed from all the dust that accumulates between them, and the instrument rendered as perfect as when it came from the hands of the maker.

INSECTS AND THEIR CLASSIFICATION.

Insects are animals which have a body consisting of one or more divisions, articulated feet, and a head conspicuously distinct from the body, on which are placed two moveable horns, called anternæ. They breathe through airholes, which are situated on the sides of the body; the greater number have wings in their perfect state, and only a proportionably small number are entirely without them. With the exception of certain groups, all perfect insects have six feet, and their bodies are divided into a head, thorax, and abdomen, by notches or incisions; hence the name *insect*, derived from the Latin word *insecare*, to cut or notch. Before they attain their perfect state they are subject to various transformations, which are called metamorphoses. For the sake of perspicuity the very numerous class of insects, the most extensive in the whole animal kingdom, has been divided into two principal divisions —the winged, and the wingless.

Winged insects are divided into the following orders:—

(1.) *Coleóptera* (Beetles; Sheath-wings). Six feet, and mostly four wings, the anterior pair of which are horny, in the form of a covering for the two posterior wings, which are sometimes wanting. They have upper and lower jaws (mandibles and maxillæ) for gnawing or chewing: their under wings are transversely folded. Examples—the may-bug, the long-horns (Cerambycidæ), stag-beetles, ground-beetles (Carábidæ), weevils, &c.

(2.) *Orthóptera* (Straight-wings.) Six feet; four wings, the two anterior of a leathery substance, serving as covers to the posterior, which are folded both longitudinally and transversely, but more generally only longitudinally (whence the name straight-wings), and which lie, when at rest, concealed under the others. They have upper and lower jaws (or mandibles and maxillæ) for chewing. Examples —the earwig, the black-beetle, the cock-roach, the field-cricket, the migratory locust, and the green grasshopper.

(3.) *Hemíptera* (Half-wings). Six feet; four wings, the two anterior forming hard coverings with membranous ends, or resembling the lower ones, but being larger and stronger. Instead of upper and lower jaws, the organs of the mouth are formed of bristles, inclosed in an articulated sheath, of a cylindrical or conical shape, and forming a projecting beak or sucker. Examples—the field and tree bugs, house bugs, cicadæ, and aphides.

(4.) *Neuróptera* (Net-wings). Six feet; four membranous naked wings, upper and lower jaws for chewing; the wings are delicately veined, the under nearly the size of the upper, or even broader in diameter. Examples—the dragon-fly, or Libéllula; lace-fly, or Hemeróbius; and day-fly, or Ephémera.

(5.) *Hymenóptera* (Membrane-wings). Six feet; four membranous wings, upper and lower jaws;— the posterior wings smaller than the upper. In the abdomen of the female of most species is a sting, or ovipositor. Examples—the saw-flies (Tenthredínidæ), Sirex gigas, gall-fly, bees, wasps, humble-bees, and ants.

(6.) *Lepidóptera* (Scale-wings). Six feet; four membranous wings, covered with small, colored, mealy, shining scales or feathers. Instead of the upper and lower jaws, two hollow filaments exist, which together form a spirally rolled tongue. Examples—butterflies, moths, and hawk-moths.

(7.) *Rhipíptera* (Fan-wings). Six feet; two membranous wings, folded like a fan; on the anterior part of a thorax are situated two small, bent, hard, moveable bodies, like wing-covers. The masticatory organs consist of simple bristle-shaped mandibles, and two palpi. To this order belong two genera of parasites living on wasps and bees.

(8.) *Díptera* (Two-wings). Six feet; two membranous expanded wings, generally with two moveable organs, called poisers or balancers, and which are situated behind the wings. The organs of the mouth consist of a sucker, formed of a variable number of bristles, which are inclosed in an unarticulated sheath; terminated in a double lip. Examples—gnats, midges, house-flies, ox and horse breeze-flies, &c.

Insects without wings consist of the following orders:—

(9.) *Myriápoda* (Thousand-feet, Millepedes).— They have more than six feet, twenty-four at least, and upwards, which are placed on a series of rings, extending the whole length of the body; each ring has generally two pairs. The first, and sometimes, also, the second pair, form parts of the mouth. Examples—the centipede, iulus, and scolopendra.

(10.) *Thysanùra* (Fringe-tails). Six feet; on the under sides of the abdomen are situated flat moveable appendages like pro-legs, and at the extremity is a forked apparatus, by which the body can raise itself and move by leaps. Example—the sugar-louse (Lepísma sacchárinum).

(11.) *Parasìta* (Parasites). Six feet; no other organs of sight except simple (instead of composite) eyes; the mouth is mostly internal, and consists of a snout, which contains a retractile sucker, or it forms a cleft with two lips, two mandibles, and hooks. Examples—the different species of lice.

(12.) *Suctòria* (Suckers). Six feet, of which the posterior are the longest, and adapted for jumping. These undergo a transformation, and acquire organs of motion which they had not at first. The mouth consists of a sucker, which is inclosed in a cylindrical sheath, and is formed of two articulated pieces. Example—the flea.

Crabs and spiders, which Linnæus included among insects without wings, are now formed into two distinct classes—Crustácea and Arachnida.

The *arrangement here given* is that of Kollar;— but other authors differ in their views of the subject. By some the earwig is formed into an order distinct from the Orthóptera. The Thríps is separated as an order from the Hemíptera, the caddice-flies (Phrygănea) from the Neuróptera and the horse-flies (Hippobósca) from the Díptera. In a popular point of view the arrangement of Kollar may be considered as sufficiently detailed.

ANIMAL MAGNETISM.

This subject has lately attracted so much of public attention, that we should not be justified in wholly omitting an account of it, more especially as it pretends to be intimately connected with subjects which we have found occasion to treat of rather fully. Before, however, we allude to the present operations of the charlatans or enthusiasts, which ever they may be, who now impose upon the credulity of the public, it will, we doubt not, be interesting to present to our readers the authenticated proceedings of the original magnetiser, M. Mesmer, with the fundamental principles upon which the pretended science was originally contrived.

On the 12th of March, 1784, Louis XVI. appointed Messrs. Borre, Lakin, Darcet, and Guillotin, members of the faculty of Paris, to examine the animal magnetism, practised by M. Deslon and Mesmer, and to give in a report to him on the subject; and in consequence of a request made by these physicians, His Majesty appointed five members of the Academy of Sciences, Messrs. Franklin, Leroi, Bailly, De Bory, and Lavoisier, to assist them in this examination. As M. Bory died when the commissioners began their labors, His Majesty made choice of M. Majault, member of the faculty of medicine, to succeed him. The following is an extract from their report:—

"*Doctrine.*—The agent which M. Mesmer pretends to have discovered, and which he has made known under the name of animal magnetism, is a fluid diffused throughout the whole universe. It is the means of a mutual influence between the celestial bodies, the earth and animated beings. It is continued in such a manner as to leave no vacuum: its subtlety is beyond all comparison; it is capable of receiving, propagating, and communicating all the impressions of motion, and is susceptible of a flux and reflux. Animal bodies experience the effects of this agent, and it is by insinuating itself into the substance of the nerves, that it immediately affects them. The human body, in particular, possesses properties analogous to those of the magnet, and it has also its different and opposite poles.

"The action and virtue of animal magnetism may be communicated from one body to other bodies, either animate and inanimate, and even at a considerable distance, without the aid of any intermediate body. It is increased and reflected by glass; it is communicated and propagated by sound—in a word, this virtue may be accumulated, concentrated, and transmitted. Though the fluid be universal, all animated bodies are not equally susceptible of it; there are some even, though few in number, of a nature so hostile to it, that their presence alone destroys all the effects of it in other bodies. Animal magnetism can cure immediately all diseases of the nerves, and others it cures mediately; it strengthens the action of medicines, and it exerts and directs salutary ones in such a manner that they may be overcome. By its means the physician can ascertain each individual's state of health; and can speak with certainty respecting the origin, nature, and progress of the most complicated diseases. He can prevent their increase, and be able to cure them without ever exposing the patient to dangerous effects, or disagreeable consequences, whatever be the age, the temperature, or the sex. In animal magnetism, nature presents an universal medium for curing and preserving mankind. Such is the agent which the commissioners were charged to examine, and such the properties warranted by M. Deslon. This physician, when he explained to the commissioners the doctrine and nature of animal magnetism, taught them also the practice, and made them acquainted with the poles, by showing them the method of touching the patients, and of conveying to them the magnetic fluid.

"*Treatment.*—After having procured information respecting the theory and practice of animal magnetism, it was necessary to see its effects. For this purpose the commissioners attended, and each of them several times, to observe the manner in which M. Deslon treated his patients. In the middle of a large hall, they saw a circular box, made of oak, raised to the height of a foot, or a foot and a half, which was called the tub; the upper part of this box was pierced with a great number of holes, from which proceeded iron branches, having moveable elbows. The patients were placed in rows around this tub, each opposite to one of the iron branches, which by means of the elbow could be applied directly to the diseased part. They were all united to each other by a rope that went round their bodies; and sometimes they formed a second chain by laying hold of each other's hands—that is to say, by each applying the thumb between the thumb and fore-finger of the next person. In a corner of the hall stood a piano-forte, on which various airs were played in different times; and these airs were sometimes accompanied with the voice and singing. All the magnetised persons held in one of their hands an iron rod, about 10 or 12 inches in length. This was called a *metallic tractor*. M. Deslon declared to the commissioners—First, that this rod was the conductor of magnetism; that it possessed the property of concentrating it at its point, and of rendering its emanations more powerful. Second, that sound, according to the principles of Mesmer, was also a conductor of magnetism, and to communicate the fluid to the piano-forte, nothing was necessary but to bring the iron rod near it; those who touched the instrument furnished it also, and the magnetism was transmitted by the sounds to the surrounding patients. Third, the rope which went round the patients, as well as the joining of hands, was destined to increase the effects by communication. Fourth, the inside of the tub was constructed in such a manner, as to concentrate the magnetism. It was a large reservoir, from which it was propagated by means of the iron branches fixed in it.

"The patients arranged in great numbers, and in several rows, around the tub, received the magnetism at the same time by all these means—by the iron branches which transmitted to them the magnetism in the tub—by the rope twisted round their bodies—by the joining of hands, which communicated to those of their neighbours; and by the sound of the piano-forte; or of an agreeable voice. The patients were magnetised also directly by means of the finger, and of an iron rod moved before the face, or behind the head, and on the diseased parts, always observing the distinction of the poles: the person who performed the operation acted upon them also by the look, and by staring at them; but they were magnetised in a particular ner by applying the fingers to the hypochon- regions, and sometimes continuing to do so several hours.

"*Effects.*—The patients exhibited a highly-varied picture, according to their different states. Some of them were calm and tranquil, and experienced no effect whatever; others coughed, spat, and felt some slight pain, a local or a universal heat, and fits of perspiration; others were agitated and tormented with convulsions, which were remarkable for their number, their duration, and violence. As soon as one convulsion began, several others manifested themselves. The commissioners saw some which lasted three hours; they were accompanied with the expectoration of a turbid, viscous liquor, forced up by the violence of the efforts. Sometimes streaks of blood came up; and one young man in particular, one of the patients, threw up a great deal of it. These convulsions were characterised by sudden and involuntary movements of all the limbs, or contraction of the throat, subsultus of the hypochondria and the epigastrion, uneasiness, a wildness of look, piercing cries, weeping, hiccups, and immoderate laughter; they were preceded and followed by a state of langour, and often a sort of dejection and even lethargy. The least unexpected noise produced in the patients a tremour; and it was observed that changing the tone and measure of the airs played on a piano-forte had an influence on them, so that by livelier tunes they were more agitated, and the vivacity of their convulsions was renewed.

"A hall, lined with matting, had been at first destined for patients afflicted with these convulsions, and on that account was called the chamber of cries; but M. Deslon does not think proper to make use of it, and all the patients, whatever be their symptoms, are collected together in the public hall.

"Nothing can be more astonishing than the appearance exhibited by these convulsions; none but those who have seen them can form any idea of them; and those who see them are not a little surprised at the profound tranquility of one part of the patients, and the agitation experienced by another; the various symptoms which are repeated, and the sympathetic emotions produced. Some patients attach themselves to each other exclusively, rush towards each other, laugh, address each other in an affectionate tone, and mutually soften each other's cries. They are all subject to him who magnetises; though in an apparent state of stupor, the sound of his voice, a look or a sign, is sufficient to rouse them from it; and in consequence of these constant effects, it is impossible not to acknowledge some great power by which the patients are agitated and subdued, and of which he who magnetises seems to be the depository.

"*Conclusion.*—The commissioners having ascertained that this animal-magnetic fluid cannot be perceived by any of our senses; that it has no action either on them, or on the patients subjected to it; and having assured themselves that pressure and touching occasion changes seldom favorable in the animal economy; and in the last place, having demonstrated by decisive experiments, that the imagination, without magnetism, produces convulsions, and that magnetism, without the imagination, produces nothing, have unanimously concluded, in regard to the question of the existence and utility of the magnetic fluid, that nothing proves its existence; that the violent effects observed on those subjected to public treatment, arise from touching; from the imagination being put in action; and from that mechanical imitation which impels us, in spite of ourselves, to repeat whatever strikes our senses. At the same time, they think themselves obliged to add, as an observation of importance, that frequent touching, and the repeated action of the imagination to produce a crisis, may be prejudicial; that the sight of these crises is equally dangerous, on account of that imagination which nature seems to have imposed on us as a law, and consequently that all the public treatment, where the means of magnetism are employed, must in the end produce disastrous effects."

Paris, March 11th, 1784.

MUSICAL STRINGS.

If a string be stretched between two pins, and then be struck or pulled to one side, it will move as far to the other side, and then nearly as far back again, and thus vibrate for a considerable time;—each vibration diminishing till they finally cease—though the time occupied in each vibration, from beginning to end, is exactly the same. Two strings in every respect the same, will produce exactly the same tone, and are said to be in *unison*. A string half the length of another will vibrate in half the time, or make two vibrations for the other one,—each second vibration of the shorter one commencing with each vibration of the longer one. A string two-thirds the length of the long string will vibrate three times to its twice. Should we suppose the long string to consist of 120 parts, and to vibrate sixty times in a second, then we may have seven divisions of it, with their according vibrations, and the number of times which each one vibrates in a second, as in the following table:—

Names of Strings.	Divisions of the Long String	According Vibrations.	Vibrations i Secon
First......	1 or 120		60
Minor Third	$\frac{5}{6}$ — 100	6 . 5	72
Major Third	$\frac{4}{5}$ — 96	5 . 4	75
Fourth....	$\frac{3}{4}$ — 90	4 . 3	80
Fifth	$\frac{2}{3}$ — 80	3 . 2	90
Minor Sixth	$\frac{5}{8}$ — 75	8 . 5	96
Major Sixth	$\frac{3}{5}$ — 72	5 . 3	100
Octave....	$\frac{1}{2}$ — 60	2 . 1	120

These strings, when struck, will produce different sounds; but the vibrations of each will accord or commence together at the above stated intervals with the original long string; and they are, therefore, said to form a concordance, or to harmonise. When the strings have not those proportions, and, consequently, not these periodical concordances, they form discords by the vibrations continually intercepting each other, and thus jarring or checking each other's momentum.

The above proportions constitute the diatonic scale, and are the foundation of all music; producing the greatest number of recurring vibrations or concords that can be had at the least intervals; and, with the addition of five intervening strings that produce half tones, each one being a sharp to the one below, and a flat to the one above, constitute the musical alphabet. All the strings together form one octave. But the same divisions may be repeated on the short string or 60, when its octave will be 30; and this may be again divided, as also its octave. Some instruments contain ten octaves, rising one above another; yet, constructed on a regular scale, so as to preserve the proportions.—The piano generally has five, but sometimes seven octaves.

The strings are not thus exactly measured in all instruments; because the least difference, either in the materials of which strings are made, their thickness or tension, which is continually varying with the weather, makes a difference in the tone. They are, therefore, fixed according to the sound itself, as determined by the accuracy of the ear;—which is called *tuning* them. The construction of most instruments must consequently depend on the ear; for in many wind-instruments, in musical glasses, and even in a great many stringed instruments, no actual proportions can be applied; and the only means we have of producing the above sets of harmonics or octaves, is, by altering and adjusting the instrument or tension of the string till the right tone is produced. In the violin the lengths of the strings are varied by the disposition of the fingers; and in the flute, the octaves are chiefly produced by the manner of blowing

The vibration of strings is on the same principle as that of pendulums; each string being considered as two pendulums joined together at the points of oscillation, and as describing very small arcs. Now, as pendulums of the same length oscillate in the same time, whether the arcs which they describe be great or small, so the vibration of equal strings will be performed in the same time: hence, though one string be violently struck so as to produce a loud sound, and another in unison, so gently as scarcely to produce any sound; yet, as each vibration is performed in the same time, the tones will have the same pitch, or the strings will be in tune.

If a pendulum of a certain length vibrate in a certain time, then one that is one-fourth the length will vibrate in half that time; the time of vibration being as the square root of the length. But to produce the same effect in the string, or double pendulum, we must work with half the length,—or as the pendulum decreases in the ratio of 1—4, the whole string must decrease as 1—2. Now, as the lengths of pendulums are measured from the point of suspension to the point of oscillation, this point of oscillation in strings must depend on the tension of the string. When the string is slack, the distance between the point of suspension and oscillation, or between one of the pegs to which the string is fastened, and the middle of the string, must be greater than when the string is tight. But perhaps the true principle is, that each string possesses elasticity only to a limited degree; and that when stretched tight, a certain portion of its elastic power is exerted lengthwise; and, therefore, when struck, there will be less to exert laterally in the vibration—it will consequently vibrate in less time. It may be possible, therefore, to make a string so tight, that all its elasticity shall be exerted longitudinally; so that when struck it will not vibrate but break.

"If the lengths and weights of two chords are the same, their times of vibrations will be inversely as the square roots of the forces with which they are stretched; and the number of vibrations which they perform in the same time, directly as those square roots. So also the tension and the weight remaining the same, the celerity of the vibration is inversely as the square root of the length, or the tension and weight per inch remaining the same, the celerity of vibration is inversely as the length. If eight strings be such, that the number of vibrations which they perform in a given time be as the numbers 24, 27, 30, 32, 36, 40, 45, 48, the sounds of the first seven will be perceived as increasing in acuteness one above another from the first to the last, and will yield the notes from the combination of which all musical effects are produced. The tone is not affected by the extent of the vibrations, but merely by their time. The loudness of their sound is supposed to depend on the greater extent of vibrations. The last of the eight strings will sound what is called the octave above the first; and the same series may be repeated again between the number 48, and its double 96, and each note will be the octave to its corresponding note in the first interval; the numbers of vibrations will be 54, 60, 64, 72, 80, 90, 96, and it is evident that this series may be continued either down or up without limit. All musical sounds are computed to be contained within ten octaves; so that the number of vibrations in a given time, that yield the gravest note, is to that which yields the most acute, as 1 to 2^{10}, or 1 to 1024."—*Playfair's Outlines of Natural Philosophy.*

Large instruments, and long, thick, and slack strings, therefore, vibrate slowly, or only once;—while instruments of diminutive size, and very short, small, and tight strings vibrate above a thousand times; the former producing grave and deep tones, and the latter sharp and acute; hence that screw-twisting and ear-torturing process that attends the tuning of stringed instruments;—and all the variety of contrivances seen in musical instruments, which are, first, for producing the above octaves; and, secondly, for playing the tones longer or shorter, when they are called notes, so as to produce such harmonious combinations of regularly recurring sounds, as we call a *tune*, an *air*, or a *melody*.

The above divisions in the length of the original long string are far from being arbitrary—they are even pointed out by Nature herself; for, should a rope of 30 or 40 feet in length be stretched very tight, and struck, it will not vibrate uniformly between end and end, but will divide itself into portions; some vibrating and some at rest,—the latter acting as bridges, or stops to the former.—Suppose the length of the rope to be 60; then the lengths of the vibrating parts must be 30, 20, and 12. For the sounds emitted are the octave, the twelfth, or octave of the fifth, and the seventeenth major or double octave of the third major of the principal sound produced by the whole rope. It is supposed to be the tendency of strings to move in this manner that produces the wild and melodious harmony of the Eolian harp; for we not only hear the natural sound of each string, but its octave, twelfth, and seventeenth. "Harmony (says a writer, in the "Edinburgh Review,") is not an adventitious quality in sonorous bodies, but is in some sense inherent in every sound, however produced.' Every sound is as much made up of three component parts as a ray of light is composed of seven (three) primary colors. In many sonorous bodies, these sounds may be made distinctly audible, as in the toll of a great bell, where, amid the vibrations of the primary or fundamental note, its 12th, and 17th are distinctly heard; that is, the note with its 3rd and 5th, composing the full harmony, are generated by the vibrations of what appears, to inattentive ears, to be only a simple sound." Something of the same kind may be observed in the report of cannon when heard from a distance. When near, all secondary vibrations are confounded in one crack; but when heard from the distance of ten or twenty miles, "it is a grave sound, which may be compared to a determinate musical sound, and instead of being instantaneous, it begins softly, swells to its greatest loudness, and then dies away growling.—Nearly the same may be observed with respect to a clap of thunder."

Another remarkable circumstance in the nature of sound is, that when an elastic propulsion of the air, producing a certain tone, strikes any sonorous body or musical instrument, which, if struck in any other manner, would produce that tone, it communicates the sound to that body or instrument, while it breaks against, or passes over others not in unison, without producing any effect. The strings of the Eolian harp are of the same length, and are tuned in unison; if one string is, therefore, struck, the whole will vibrate or produce sound; but if only two are in unison, and one of them be struck, the other only will vibrate. This may be proved by hanging pieces of paper on all the strings; when, if one be struck, the paper will immediately fly off the other in unison with it, but will remain undisturbed upon the rest. Though the strings all produce the same combinations of natural concords; yet, as the wind that plays upon them is perpetually varying its intensity, its sportive sweeps "produce a variety and sweetness of harmony, which, heard in the stillness of evening, may almost be mistaken for an unearthly music."

To this sympathy in the elastic properties of matter it is owing that one thing, and perhaps only that one in a room will begin to dance, vibrate, or emit sound to one particular note of an organ, or any other instrument, while all the other notes have no effect upon it. These corresponding notes are called the key notes; and such foundation has this in nature, that it is not confined to inanimate objects. A dog will begin to howl at one particular note, though indifferent to all the rest of the gamut; and even man himself has the key-note to each of his passions; and hence it is, that his soul is so moved with music, and that he is often compelled, even in defiance of himself, to laugh with those that laugh, and weep with those that weep.

ANALYSIS OF MINERAL WATERS.

(Resumed from page 149.)

THERE is sometimes found in water a quantity of bitumen combined with alkali, and in the state of soap. In such waters acids occasion a coagulation; and the coagulum collected on a filter discovers its bituminous nature by its combustibility. Water, also, sometimes contains extractive matter; the presence of which may be detected by means of nitrate of silver. The water suspected to contain it must be freed from sulphuric and nitric acid, by means of nitrate of lead; after this, if it give a brown precipitate with nitrate of silver, we may conclude that extractive matter is present.

But it is not sufficient to know that a mineral water contains certain ingredients; it is necessary to ascertain the proportions of these, and thus we arrive at their complete analysis.

1. The different aërial fluids ought to be first separated and estimated. For this purpose, a retort should be filled two-thirds with the water, and connected with a jar full of mercury, standing over a mercurial trough. Let the water be made to boil for a quarter of an hour. The aërial fluids will pass over into the jar. When the apparatus is cool, the quantity of air expelled from the water may be determined either by bringing the mercury within and without the jar to a level; or, if this cannot be done, by reducing the air to the proper density by calculation. The air of the retort ought to be carefully subtracted, and the jar should be divided into cubic inches and tenths.

The only gaseous bodies contained in water are, common air, oxygen gas, nitrogen gas, carbonic acid, sulphuretted hydrogen gas, and sulphurous acid. The last two never exist in water together. The presence of either of them must be ascertained previously by the application of the proper tests.—If sulphuretted hydrogen gas be present, it will be mixed with the air contained in the glass jar, and must be separated before this air be examined. For this purpose the jar must be removed into a tub of warm water, and nitric acid introduced, which will absorb the sulphuretted hydrogen. The residuum is then to be again put into a mercurial jar and examined.

If the water contain sulphurous acid, this previous step is not necesary. Introduce into the air a solution of pure potash, and agitate the whole gently. The carbonic acid and sulphurous acid gas will be absorbed, and leave the other gases. The bulk of this residuum, subtracted from the bulk of the whole, will give the bulk of the carbonic acid and sulphurous acid absorbed.

Evaporate the potash slowly, almost to dryness, and leave it exposed to the atmosphere. Sulphate of potash will be formed, which may be separated by dissolving the carbonate of potash by means of diluted muriatic acid, and filtering the solution.—100 grains of sulphate of potash indicate 36.4 grains of sulphurous acid, or 53.66 cubic inches of that acid in the state of gas. The bulk of sulphurous acid gas ascertained by this method, subtracted from the bulk of the gas absorbed by the potash, gives the bulk of the carbonic acid gas. Now 100 cubic inches of carbonic acid, at the temperature of 60°, and barometer 30 inches, weigh 46.6 grains. Hence it is easy to ascertain its weight.

When a water contains sulphuretted hydrogen gas, the bulk of this gas is to be ascertained in the following manner:—Fill three-fourths of a jar with the water to be examined, and invert it in a water trough, and introduce a little nitrous gas. This gas, mixing with the air in the upper part of the jar, will form nitrous acid, which will render the water turbid, by decomposing the sulphuretted hydrogen and precipitating sulphur. Continue to add nitrous gas at intervals as long as red fumes appear, then turn up the jar and blow out the air. If the hepatic smell continue, repeat this process. The sulphur precipitated indicates the proportion of hepatic gas in the water; one grain of sulphur indicating the presence of nearly 3 cubic inches of this gas.

2. After having estimated the gaseous bodies, the next step is to ascertain the proportion of the earthy carbonates. For this purpose it is necessary to deprive the water of its sulphuretted hydrogen, if it contain any. This may be done, either by exposing it to the air for a considerable time, or treating it with litharge. A sufficient quantity of the water, thus purified if necessary, is to be boiled for a quarter of an hour, and filtered when cool. The earthy carbonates remain on the filter.

The precipitate thus obtained may be carbonate of lime, of magnesia, of iron, of alumina, or even sulphate of lime. Let us suppose all of these substances to be present together. Treat the mixture with diluted muriatic acid, which will dissolve the whole except the alumina and sulphate of lime.—Dry this residuum in a red-heat, and note the weight. Then boil it in carbonate of soda, saturate the soda with muriatic acid, and boil the mixture for half an hour. Carbonate of lime and alumina precipitate. Dry this precipitate, and treat it with acetic acid. The lime will be dissolved, and the alumina will remain. Dry it and weigh it. Its weight subtracted from the original weight, gives the proportion of sulphate of lime.

The muriatic solution contains lime, magnesia, and iron. Add ammonia as long as a reddish precipitate appears. The iron and part of the magnesia are thus separated. Dry the precipitate, and expose it to the air for some time in a heat of 200°; then treat it with acetic acid to dissolve the magnesia, which solution is to be added to the muriatic solution. The iron is to be re-dissolved in muriatic acid, precipitated by an alkaline carbonate, dried and weighed.

Add sulphuric acid to the muriatic solution as long as any precipitate appears; then heat the solution and concentrate. Heat the sulphate of lime, thus obtained, to redness, and weigh it. 100 grains of it are equivalent to 74.7 of carbonate of lime dried. Precipitate the magnesia by means of carbonate of soda. Dry it and weigh it. But as part remains in solution, evaporate to dryness, and wash the residuum with a sufficient quantity of distilled water, to dissolve the muriate of soda and sulphate of lime, if any be still present. What remains behind is carbonate of magnesia. Weigh it, and add its weight to the former. The sulphate of lime, if any, must also be separated and weighed.

(To be continued.)

MISCELLANEOUS EXPERIMENTS.

Into a large glass jar, inverted upon a flat brick tile, and containing near its top a branch of fresh rosemary, or any other such shrub, moistened with water, introduce a flat thick piece of heated iron, on which, place some gum benzoin in gross powder. The benzoic acid, in consequence of the heat, will be separated, and ascend in white fumes, which will at length condense, and form a most beautiful appearance upon the leaves of the vegetable. This will serve as an example of *sublimation*.

Introduce a little carbonate of ammonia into a Florence flask, and place that part of the flask which contains the salt on the surface of a basin of boiling water: the heat will soon cause the carbonate of ammonia to rise undecomposed, and attach itself to the upper part of the vessel, affording another example of *simple sublimation*.

Fill a glass tumble half full of lime water; then breathe into it frequently; at the same time stirring it with a piece of glass. The fluid, which before was perfectly transparent, will presently become quite white, and if suffered to remain at rest, *real chalk* will be deposited.

Mix a little acetate of lead with an equal portion of sulphate of zinc, both in fine powder; stir them together with a piece of glass or wood, and no chemical change will be perceptible: but if they be rubbed together in a mortar, the two solids will operate upon each other; an intimate union will take place, and a *fluid will be produced*. If alum or Glauber salt be used instead of sulphate of zinc, the experiment will be equally successful.

Put a little fresh calcined magnesia in a tea-cup, upon the hearth, and suddenly pour over it as much concentrated sulphuric acid as will cover the magnesia. In an instant sparks will be thrown out, and the mixture will be *completely ignited*.

Put a little alcohol in a tea-cup, set it on fire, and invert a large bell glass over it. In a short time an aqueous vapour will be seen to condense upon the inside of the bell, which, by means of a dry sponge, may be collected, and its quantity ascertained. This may be adduced as an example of the formation of *water by combustion*.

Put a small piece of phosphorus into a crucible, cover it closely with common chalk, so as to fill the crucible. Let another crucible be inverted upon it, and both subjected to the fire. When the whole has become perfectly red hot, remove them from the fire, and when cold, the carbonic acid of the chalk will have been decomposed, and the *black charcoal*, the basis of the acid, may be easily perceived amongst the materials.

Let sulphuric acid be poured into a saucer upon some acetate of potass. Into another saucer put a mixture of about two parts quick-lime, and one of sal ammoniac, both in powder, adding to these a *very small* quantity of boiling water. Both saucers while separate will yield *invisible* gases: but the moment they are brought close together, the operator will be *enveloped in very visible vapours*.—Muriate of soda, in this experiment, may be substituted for acetate of potass.

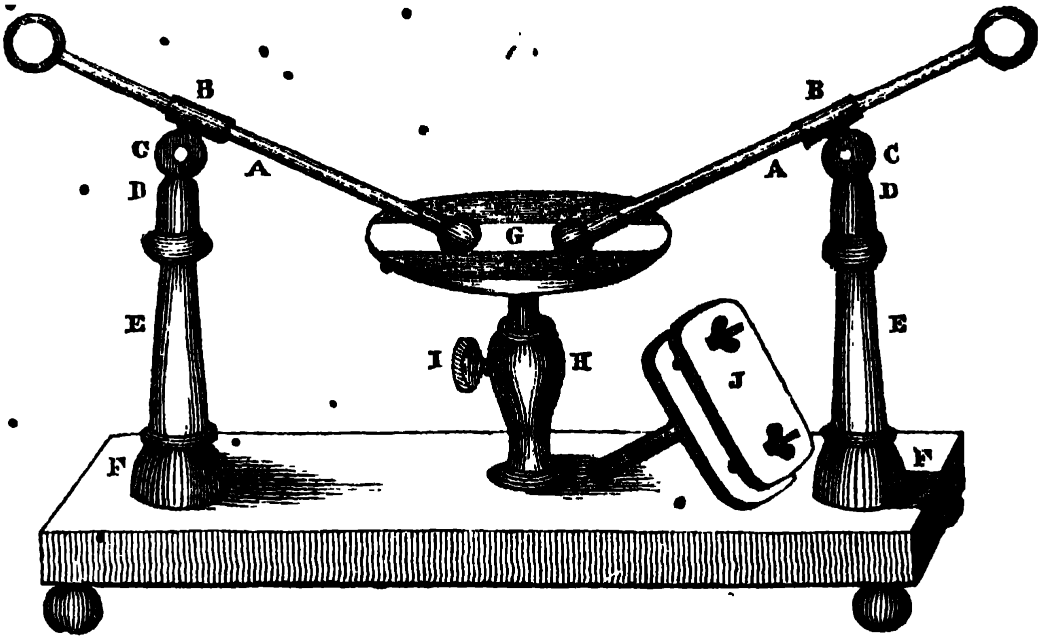
Take a glass tube with a bulb in form of a common thermometer; fill it with cold water, and suspend it by a string. If the bulb be frequently and continually moistened with pure sulphuric ether, the water will presently be *frozen, even in summer*.

Dissolve five drams of muriate of ammonia, and five drams of nitre, both finely powdered, in two ounces of water. A thermometer immersed in the solution will show that the temperature is reduced below 32°. If a thermometer tube, filled with water, be now suspended within it, the *water* will soon be *as effectually frozen* as in the last experiment.

Procure a phial with a glass stopper accurately ground into it; introduce some copper wire, then entirely fill it with liquid ammonia, and stop the phial so as to exclude all atmospheric air. If left in this state, no solution of the copper will be effected. But if the bottle be afterwards left open for some time, and then stopped, the metal will dissolve, and the solution will be colorless. Let the stopper be now taken out, and the fluid will become blue, beginning at the surface, and spreading gradually through the whole. If this blue solution has not been too long exposed to the air, and fresh copper filings be put in, again stopping the bottle, the fluid will once more be deprived of its *color*, which it will *recover only by the re-admission of air*.—These effects may thus be repeatedly produced.

Take a phial with a solution of sulphate of zinc, and another containing a little liquid ammonia, both transparent fluids. By mixing them, a curious phenomenon may be perceived:—the zinc will be immediately precipitated in a white mass, and if then shaken, almost as *instantly re-dissolved*.

Fig. 1.



ELECTRICAL EXPERIMENTS AND APPARATUS.

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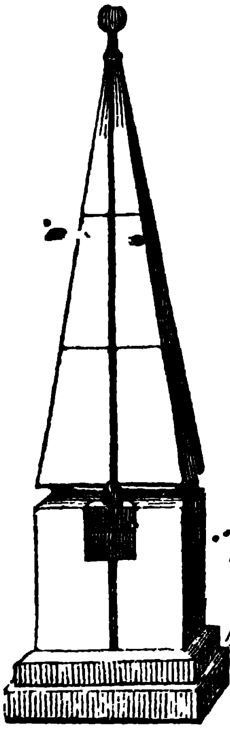

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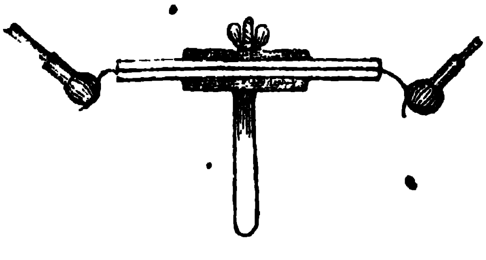

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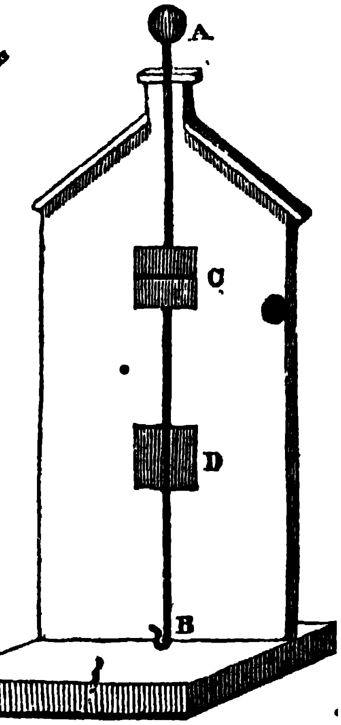

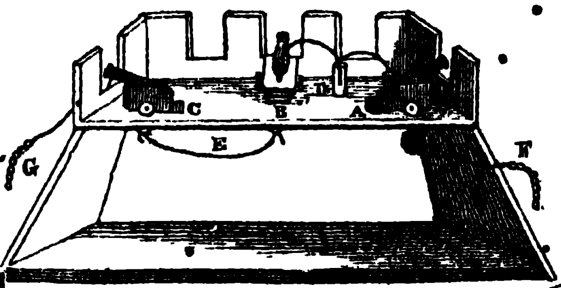

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ELECTRICAL EXPERIMENTS AND APPARATUS.

THE object of the present paper is to prove, by experiment, the identity between the electric fluid and lightning. We have already stated that they are identical, and in Vol. I, page 333, adduced numerous reasons in confirmation of the fact. We shall now show upon what direct proofs the identity of the two rest; and, at the same time, explain the nature of some useful electrical apparatus and experiments.

It is necessary that when we operate with accumulated electricity, and desire to pass a shock through a substance, that we should have some means of holding it steadily, and directing the fluid in the exact line which we desire. No apparatus is so well adapted for general purposes of this nature, as *Henley's Universal Discharger*, represented in Fig. 1. A A are two thick brass wires, each terminated at one end by a ring, and at the other by a ball and socket, which slips on and off, so that the instrument may be used with or without the balls, as required for particular experiments. The wires may be drawn out or in by sliding them through the sockets B B; they may be lifted up or down by the joints C C, and they have a motion sideways by a ball and socket, or other joint at D D; all this part is of brass. The wires are supported upon the two glass pillars E E, which fit by their lower ends into the wooden feet F F, these last screwing into the stand. The centre part of the instrument consists of a small table of wood, with a piece of ivory let in the top of it, G, and with a spindle below, fitting in the support H, and bound at any required height by the screw I. The letter J shows a small press of two pieces of baked wood, with screws to hold them together, and a spindle similar to that of the table, for which this press is sometimes substituted. When the universal discharger is to be used, the two rings of the wires are to be connected with the opposite sides of an electrical jar or battery. The object through which the shock is to be passed, is to be placed on the ivory which is upon the table, one ball or wire touching each side of the object.

Having described this instrument, we proceed to prove that all the effects of lightning can be easily imitated by the ordinary electrical machine and apparatus; and, in doing so, it will be necessary to recapitulate the chief effects of lightning.

First—Lightning destroys animal and vegetable life, so does electricity.

Ex. 1.—Procure a mouse and send a strong shock through his body, from head to tail, and the poor animal will instantly fall dead. To pass the shock through the head or chest seldom kills, but if it pass along the spinal marrow it always does—the tail should therefore form part of the circuit. We may be allowed to caution the young experimenter, when amusing himself in electrifying his friends, never to pass a shock along the back-bone, it often causes distressing symptoms for a long time, and may even occasion partial or general paralysis.

Ex. 2.—The same sudden death will seize upon a flounder or other small fish, if a very trifling shock be passed through it, or a stronger one through the water in which it is placed.

Ex. 3.—Pass a strong shock from the top to the root of a balsam or geranium, and although no immediate effect will be apparent, yet the plant will be effectually killed, as will be evident after a few days.

Second—Lightning often renders steel magnetic, and disturbs the magnetism of such as is already magnetized. That this is the case, is a matter of notoriety. The compass needles on board ship are often seriously injured from this cause; and that it does not always occur when a shock is passed through a magnetized needle depends upon the circumstance that the electrical and magnetic fluids, act the one tangential to the other, and unless the lightning passes close to the magnetic needle, and in a direction tangential to it, or across it, but little effect will take place. This is fully explained, and the method of making a magnet described in page 298, of Vol. II, in an article on electro-magnetism.

Third—Lightning destroys metals, so does electricity.

Lightning conductors, the leaden pipes of houses and churches, and other metallic substances, are too often seriously injured, if not totally destroyed, when lightning has struck them. This is because the metallic substance has not been sufficient to convey away the passing fluid. There are many experiments which may be conducted with ordinary electricity, that show the same effect as well as the reduction of metallic oxydes; among the most easily conducted of which are the following.—

Ex. 4.—Procure two pieces of flat window glass, about 3 inches long, 1½ inch broad; lay between them a strip of gold-leaf, ½ an inch or more broad, and long enough to hang out at each end. Bind these glasses together with a piece of string, or fasten them in the little press belonging to the universal discharger, previously described, put the press in its place, and the two balls of the wires, so as to touch the projecting ends of the gold-leaf;—pass a strong shock through the leaf and it will be melted, oxydated, and driven into the surface of the glass. This experiment is illustrated by Fig. 2.

Ex. 5.—Elevate and separate from each other the two balls of the universal discharger; twist a very fine iron wire from one to the other; then send a shock through them and the wire, and if the shock be strong enough the wire will immediately become red hot, or be melted.

Ex. 6.—Paint one side of a card with the common water color called vermillion, and laying it on the table of the discharger, rest the balls upon it at the distance from each other of about an inch; passing the shock the fluid will run along the surface of the painted card, and its passage be marked by a strong black mark on the red surface, extending from one ball to the other. If the balls are taken off and the points of the wires rested on the card, the effect will be the same or even more decided than when the balls are used. Occasionally a double line will be seen.

Fourth—Lightning rends to pieces trees, houses, and other bodies opposed to its passage, so does electricity.

Ex. 7.—Rest upon the table of the discharger, a piece of white paper, 4 or 5 inches square, and placing the two balls about 2 inches from each other, send a shock along the surface of the paper, when it will be rent in pieces along the line which the fluid travels.

Ex. 8.—Pass the shock through a card, by placing the balls of the discharger on each side of, and close to it, a minute hole will be pierced through the card, and what is very singular, a *burr* or projecting edge is formed on each side of the card. This circumstance has been alleged as a proof that there are two electric fluids; one of which crosses the other in its passage, and each producing its own burr. It is also argued, that the passage of the fluid in one direction only, that is from the positive to the negative side, could produce but one burr, in the same way as a pin would do thrust through the card. This is an unwise inference, because a *drill* or indeed any tool if forced through a yielding substance, like a card, by a circular motion, leaves a *burr* on both sides, as may be easily proved by a taper bitt and iron hoop; or by a screw forced through the cover of a book, or a *rimer* turned round in a piece of leather. That this electric fluid is forced forward towards the negative surface is evident from the very nature of a shock, and that it has a circular motion at the same time, the whole science of electro-magnetism seems to prove. A shock may be passed through three or four cards at once, and each have its double burr.

Ex. 9.—Hang to the ceiling four or five sheets of brown paper, and pass a shock through it; the whole of the paper will be pierced, without the paper being in the slightest degree moved. Upon smelling the part of the paper which has been pierced, it will be found to have a combined scent of sulphur and phosphorus; a scent exactly analogous to that perceived when lightning has struck an object close at hand.

Ex. 10.—Place between the two balls of the discharger a small lump of sugar, and send a shock through it; the sugar will perhaps be broken, if not, send a second and a third shock through it, when unless the shocks have been very weak, and the lump large, it will not fail to be broken into many pieces. If this experiment be performed in the dark, the sugar will give out at the time of the shock, and for half a minute afterwards, a strong phosphoric light.

Ex. 11.—*The Thunder House* is an apparatus which shows the effects of lightning and its imitation. It is represented in Fig. 3, and consists of an upright piece of baked wood, made like the gable of a house, placed upon a wooden stand. A strong wire, with a ball at one end and a hook at the other, runs down the upright piece; it is interrupted in one or two places, by a hole cut in the upright, about one inch square and a quarter of an inch into the surface; into these holes are fitted squares of wood, that take out and in very easily. They have a wire running across them in one direction, so that if the squares are placed in one way, the whole upright is furnished with a continuous wire; if the other way, the wire is interrupted, because the wire in the small piece or pieces runs across. If placed so as to be continuous, a shock may be passed down the whole house, without injury; but if either of the pieces are placed with the wire across, that piece upon passing the shock through the wire would be thrown out, showing a close analogy with the effects of lightning, when it passes down an imperfect, or rather an interrupted conductor.

Ex. 12.—Fig. 4 represents *The Electrical Obelisk*, which consists of four pieces of wood, standing on each other; the three upper ones resting on three balls. The front ball is supported by a moveable piece of wood, like that in the thunder house, and when the shock is passed, the piece is thrown out in like manner, and of course lets the obelisk fall.

Fifth—Lightning sets fire to stacks, ships, buildings, &c.

We have already, in a paper showing the heating effects of electricity, (in Vol. II, page 322,) seen that various substances may be readily inflamed by the spark and shock; we need not, therefore, dwell long upon this, yet the present notice would be incomplete were we wholly to omit an illustration or two.

Ex. 13.—*Rosin Fired.*—Tie loosely round one of the balls of the universal discharger, or round the ball of a common discharging rod, a little loose tow; when tied on, roll it in powdered rosin, and send a sudden shock through it, when the rosin will be inflamed

Ex. 14.—Fig. 5 shows *The Electrical Fort;* we have shown it with three cannons, but it is more convenient and effective with four. The cannons and fort are of ordinary make, observing only that the fort should be of very dry baked wood, and the cannons have extra touch-holes made of a piece of paper, shaped like a funnel, and fixed on with sealing wax, so that there may be a greater body of gunpowder than they would otherwise hold. The passage of the fluid is as follows:—One side of the charged Leyden jar is connected with a chain that dips in a basin of water. The chain F also dips in the same water by one end, and is connected with the outside of the cannon A. The fluid then passes through the gunpowder of this cannon to the wire D, and runs along this to the next cannon B. It passes through the gunpowder here, and inflames it, as it did the former; it has now reached the outside of this cannon, and passes by a wire E, under the platform of the fort to the outside of the last cannon C, and then goes through the touch-hole to a wire G, that may lead it away to the Leyden jar again; thus completing the circuit, and proving, at the same time, the inflaming effects of the electric fluid and its great rapidity of motion, as it will be found that the cannons, however numerous, or however far apart, all go off so simultaneously as to be heard as but one report.

CONVERSION OF CARBON INTO SILICON.

A DISCOVERY has been lately made, which is likely to extend widely the boundaries of chemical science. The views of the alchymists, with regard to the transmutation of metals, are now shown to be of possible realisation. Chemists have ceased to draw any line of distinction between those bodies ordinarily termed metals, and other elementary substances; *i. e.* in proceeding through the list of elements from oxygen to platinum, we cannot say where the metallic property commences. Now Dr. S. Brown, of Edinburgh, has given proof, in a paper read before the Royal Society of that place, that the elementary body, carbon, can be converted into silicon, which last substance was, not long ago, considered metallic. Observe, this is not the decomposition of silicon, or rather the formation of it, from a new base, but the proof of the absolute convertibility of one elementary body into another, which we must still regard as simple. This grand discovery, second to none that has ever been made in science, and likely to prove of vast benefit in its results to the resources of the arts, is the work of a young man—who had, however, given proof of the greatest powers—*ex pede Herculem.* Like other great discoveries, it has been preceded by such indicative facts as might gradually induce us to regard it as possible. We allude to the doctrines and facts of isomerism, which showed that some compound bodies, presenting on analysis the same chemical composition, might yet differ greatly in properties. In these cases it was conceived that the atoms might be differently arranged, or that the composition of the one body might be represented by doubling the atoms of the other, and so forth. Thus, if we have a body whose composition may be represented by *a b*, we may write it *b a*, or twice *a b*. Now, as our only reason for believing any body to be simple is, that we are unable to decompose it, it is quite possible that some of the bodies which we call simple might really be compound and isomeric. But to sum up the facts presented by Dr. Brown:—His late communication is purely of a practical character, the author having refrained from presenting what he conceives to be the *rationale* of the singular facts he has discovered, until further investigations of a similar kind shall have been executed by himself or others. The manner in which the author establishes the isomerism of carbon and silicon is very simple, and consists in giving a great many processes by which the former may be converted into the latter. These are contained in a series of five sections. The first treats of the production of silicon from free paracyanozen; the second, of the formation of mixed siliciurets of copper, iron, and platinum, by the re-action of paracyanozen; the third, of the quantity of nitrogen separated from paracyanozen, when it is changed into nitrogen and silicon; the fourth describes processes for the preparation of transparent crystallised siliciuret of iron from the paracyanide of iron and the ferro-cyanide of potassium; and the fifth gives easy processes for the extraction of silicic acid from ferrocyanide of potassium by the action of carbonated potass. The last of these processes has been repeated in the laboratory of the Newcastle Medical School, and found to give the result described by Dr. Brown.—*Mining Journal.*

ON CHLORINE.

Chlorine was discovered by Scheele in his experiments on oxygen, in 1774; he called it dephlogisticated muriatic acid, but it afterwards obtained the name of oxy-muriatic acid.

Its specific gravity, compared to hydrogen, is 33·5 to 1; 100 cubic inches weighing 73·375 grains.

It is a permanently elastic gaseous fluid, having a pungent and disagreeable odour, and being highly injurious when respired, even though it be largely diluted with atmospheric air. Its color is a greenish yellow. Chlorine is not altered when exposed to the highest temperature, which was proved by Sir H. Davy, by means of the following experiments:—

Ex. 1.—Provide a glass globe of about 4 inches in diameter, having at its upper part a sliding wire passing air-tight through a ground collar, to the lower end of which is attached a piece of well burned charcoal. At the bottom is a stop-cock supporting a pair of brass pincers, in which there is another piece of charcoal. The globe is exhausted upon the air-pump, filled with chlorine, and the stop-cock and sliding wire attached to the extremities of a galvanic battery. The charcoal points are then pushed down, and retained as long as necessary in ignition.

Ex. 2.—To obtain chlorine from black oxyde of manganese and muriatic acid; provide 4 ounces of the oxyde, and add as much muriatic acid as will make it of the consistence of thick cream. Heat it in a glass retort, and collect the gas at the pneumatic trough, but observe that it is absorbable by cold water, and only partially so by hot.

Ex. 3.—From black oxyde of manganese, salt, water, and sulphuric acid, take 8 parts of common salt, 3 of the oxyde, 4 of water, and 5 of sulphuric acid.

Ex. 4.—Take one volumn of water and two of chlorine, and the water will absorb the gas. This solution is of a pale yellow color, has an astringent taste, and destroys vegetable colors; hence its use in bleaching, though the gas itself, when perfectly free from moisture, has hardly any effect on them.

Ex. 5.—Take a small piece of phosphorus and put it in a deflagrating ladle, and immerse it in a jar of chlorine, when it will burn with great brilliancy.

Ex. 6.—Provide a wire, and attach a piece of a taper, and immerse into chlorine; when the brilliancy of the flame becomes impaired, it appears red, throws off much carbon, and is nearly extinguished.

Ex. 7.—Vary Ex. 5 by introducing copper leaf, antimony in powder, and a few other metals.

Ex. 8.—To make oxyde of chlorine, proceed as follows:—Upon 10 or 12 grains of chlorate of potash, drop a small quantity of sulphuric acid, and stir the mixture with a platinum knife, having so adjusted the relative quantities of the salt and acid that they may form together a yellow liquid. Put this into a small retort, and heat it by means of a water bath to 150°. Oxyde of chlorine will pass off, and may be collected over quicksilver in small jars or tubes. The oxyde has an odour somewhat resembling that of chlorine, but much less irritating and disagreeable. Its taste is astringent, and not at all acid. It dissolves in water, forming a lemon-yellow colored solution.

Ex. 9.—Heat gently some oxyde of chlorine, and it will be decomposed with explosion and expansion. Two volumns are enlarged into three, of which two consist of oxygen, and one of chlorine; it is therefore composed of 33·5 parts, by weight, of chlorine, combined with 30 of oxygen. This gas was originally called euchlorine by Sir H. Davy.

Ex. 10.—To obtain chloric acid, take a mixture of oxyde of silver and water, and pass a current of chlorine through it. Chloride of silver is produced, which is insoluble, and may be separated by filtration. The excess of chlorine, which the filtered liquor contains, is separable by heat, and the chloric acid, dissolved in water, remains. It is a sour, colorless liquid, producing peculiar compounds, such as chlorate of potash. It forms no precipitates in metallic solutions.

Ex. 11.—Muriatic acid, (or according to the new nomenclature hydro-chloric acid,) is a compound of hydrogen and chlorine. Mix equal volumns of these gases, and expose them to the light, and the acid will be formed. Having another portion ready, expose it to the direct solar rays, and a detonation will ensue. The same result is observed if it be exposed to the light of the voltaic discharger.

Ex. 12.—Chloride of nitrogen. Chlorine and nitrogen do not unite directly; but the compound may be obtained by exposing a solution of nitrate or muriate of ammonia to the action of a current of chlorine at the temperature of 60° or 70°. The gas is absorbed, and an oil-like fluid heavier than water is produced. This should be experimented upon with great care, as it is very explosive.

Ex. 13.—Ammonia and chlorine. When these gases are mixed, a partial decomposition of the former ensues. Take of ammonia 40 parts, and mix with 15 of chlorine; 5 parts of nitrogen are liberated, and muriate of ammonia is formed. If the gases be perfectly dry, heat is evolved, and a flame is said to traverse the vessel in which the muriate is formed.

Ex. 14.—Chloride of sulphur. Heat sulphur in chlorine; it absorbs rather more than twice its weight of the gas, and forms a greenish yellow liquid, consisting of 15 sulphur and 33·5 of chlorine. It exhales suffocating and irritating fumes when exposed to the air. Its specific gravity is 1·6, and dissolves sulphur and phosphorus.

Ex. 15.—Chloride of phosphorus, consisting of ·11 phosphorus and 33·5 chlorine, is procured by distilling a mixture of phosphorus and corrosive sublimate, or perchloride of mercury. Calomel or the protochloride is left in the retort, and the phosphorus combines with one proportion of chlorine as it passes over.

Ex. 16.—Take a jar of chlorine and immerse in it a paper dipped in oil of turpentine, and the gas will inflame the turpentine.

Caution.—Chlorine must be experimented upon with great care, from its pungent odour and suffocating properties; and it is advisable for young beginners not to experiment with such things as oxyde of chlorine, chloride of nitrogen, &c.

CHEMICUS AMATOR.

ANALYSIS OF MINERAL WATERS.

(Resumed from page 168, and concluded.)

3. We have next to ascertain the proportion of mineral acids or alkalis, if any be present uncombined. The acids which may be present, omitting the gaseous, are the sulphuric, muriatic, and the boracic.

The proportion of sulphuric acid is easily determined. Saturate it with barytes water, and ignite the precipitate. 100 grains of sulphate of barytes thus formed indicate 34.0 of real sulphuric acid.

Saturate the muriatic acid with barytes water, and then precipitate the barytes by sulphuric acid. 100 parts of the ignited precipitate are equivalent to 23.73 grains of real muriatic acid.

Precipitate the boracic acid by means of acetate of lead. Decompose the borate of lead by boiling it in sulphuric acid. Evaporate to dryness. Dissolve the boracic acid in alcohol, and evaporate the solution; the acid left behind may be weighed.

To estimate the proportion of alkaline carbonate present in a water containing it, saturate it with sulphuric acid, and note the weight of real acid necessary. Now 100 grains of real sulphuric acid saturate 120.0 potash, and 80.0 soda.

4. The alkaline sulphates may be estimated by precipitating their acid by means of nitrate of barytes, having previously freed the water from all other sulphates; for 14.75 grains of ignited sulphate of barytes indicate 9.0 grains of dried sulphate of soda; while 14.75 sulphate of barytes indicate 11 of dry sulphate of potash.

Sulphate of lime is easily estimated by evaporating the liquid containing it, to a few ounces (having previously saturated the earthy carbonates with nitric acid), and precipitating the sulphate of lime by means of weak alcohol. It may then be dried and weighed.

The quantity of alum may be estimated by precipitating the alumina by carbonate of lime or of magnesia (if no lime be present in the liquid).—Eleven grains of the alumina, heated to incandescence, indicate 100 of crystallized alum, or 55 of dried salt.

Sulphate of magnesia may be estimated, provided no other sulphate be present, by precipitating the acid by means of a barytic salt, as 14.75 parts of ignited sulphate of barytes indicate 7.46 of sulphate of magnesia. If sulphate of lime, and no other sulphate, accompany it, this may be decomposed, and the lime precipitated by carbonate of magnesia. The weight of the lime thus obtained, enables us to ascertain the quantity of sulphate of lime contained in the water. The whole of the sulphuric acid is then to be precipitated by barytes. This gives the quantity of sulphuric; and subtracting the portion which belongs to the sulphate of lime, there remains that which was combined with the magnesia, from which the sulphate of magnesia may be estimated.

If sulphate of soda be present, no earthy nitrate or muriate can exist. Therefore, if no other earthy sulphate be present, the magnesia may be precipitated by soda, dried and weighed; 2.46 grains of which indicate 7.46 grains of dried sulphate of magnesia. The same process succeeds when sulphate of lime accompanies these two sulphates;—only in this case the precipitate, which consists both of lime and magnesia, is to be dissolved in sulphuric acid, evaporated to dryness, and treated with twice its weight of cold water, which dissolves the sulphate of magnesia, and leaves the other salt. Let the sulphate of magnesia be evaporated to dryness, exposed to a heat of 400°, and weighed. The same processes succeed, if alum be present instead of sulphate of lime. The precipitate in this case, previously dried, is to be treated with acetic acid, which dissolves the magnesia, and leaves the alumina. The magnesia may be again precipitated, dried, and weighed. If sulphate of iron be present, it may be separated by exposing the water to the air for some days, and mixing with it a portion of alumina.—Both the oxide of iron, and the sulphate of alumina, thus formed, precipitate in the state of an insoluble powder. The sulphate of magnesia may then be estimated by the rules above given.

Sulphate of iron may be estimated by precipitating the iron by means of prussic alkali, having previously determined the weight of the precipitate produced by the prussiate in a solution of a given weight of sulphate of iron in water. If muriate of iron be also present, which is a very rare case, it may be separated by evaporating the water to dryness, and treating the residuum with alcohol, which dissolves the muriate, and leaves the sulphate.

5. If muriate of potash or of soda, without any other salt, exist in water, we have only to decompose them by nitrate of silver, and dry the precipitate; for 18.2 of muriate of silver indicate 9.5 of muriate of potash; and 18.2 of muriate of silver indicate 7.5 of common salt.

The same process is to be followed, if the alkaline carbonates be present; only these carbonates must be previously saturated with sulphuric acid; and we must precipitate the muriatic acid by means of sulphate of silver instead of nitrate. The presence of sulphate of soda does not injure the success of this process.

If muriate of ammonia accompany either of the fixed alkaline sulphates, without the presence of any other salt, decompose the sal ammoniac by barytes water, expel the ammonia by boiling, precipitate by diluted sulphuric acid, and saturate the muriatic acid with soda. The sulphate of barytes thus precipitated, indicates the quantity of muriate of ammonia, 14.75 grains of sulphate indicating 67.0 grains of this salt. If any sulphates be present in the solution, they ought to be previously separated. If common salt be accompanied by muriate of lime, muriate of magnesia, muriate of alumina, or muriate of iron, or by all these together, without any other salt, the earths may be precipitated by barytes water, and redissolved in muriatic acid.—They are then to be separated from each other by the rules formerly laid down, and their weight, being determined, indicates the quantity of every particular earthy muriate contained in the water. For 50 grains of lime indicate 100 of dried muriate of lime; 30 grains of magnesia indicate 100 of the muriatic of that earth; and 21.8 grains of alumina indicate 100 of the muriate of alumina. The barytes is to be separated from the solution by sulphuric acid, and the muriatic acid expelled by heat, or saturated with soda; the common salt may then be ascertained by evaporation, subtracting in the last case the proportion of common salt indicated by the known quantity of muriatic acid, from which the earths had been separated.

When sulphates and muriates exist together, they ought to be separated either by precipitating the sulphates by means of alcohol, or by evaporating the whole to dryness, and dissolving the earthy muriates in alcohol. The salts thus separated may be estimated by the rules already laid down.

When alkaline and earthy muriates and sulphate of lime occur together, the last is to be decomposed by means of muriate of barytes. The precipitate ascertains the weight of sulphate of lime contained in the water. The estimation is then to be conducted as when nothing but muriates are present, only from the muriate of lime that proportion of muriate must be deducted, which is known to have been formed by adding the muriate of barytes.

When muriates of soda, magnesia, and alumina, are present together with sulphates of lime and magnesia, the water to be examined ought to be divided into two equal portions. To the one portion add carbonate of magnesia, till the whole of the lime and alumina is precipitated. Ascertain the quantity of lime, which gives the proportion of sulphate of lime. Precipitate the sulphuric acid by muriate of barytes. This gives the quantity contained in the sulphate of magnesia and sulphate of lime;—subtracting this last portion, we have the quantity of sulphate of magnesia.

From the second portion of water, precipitate all the magnesia and alumina by means of lime-water. The weight of these earths enables us to ascertain the weight of the muriate of magnesia and of alumina contained in water, subtracting that part of the magnesia which existed in the state of sulphate, as indicated by the examination of the first portion of water. After this estimation, precipitate the sulphuric acid by barytes water, and the lime by carbonic acid. The liquid, evaporated to dryness, leaves the common salt.

6. It now only remains to explain the method of ascertaining the proportion of the nitrates which may exist in waters.

When nitre accompanies sulphates and muriates without any other nitrates, the sulphates are to be decomposed by acetate of silver. The water, after filtration, is to be evaporated to dryness, and the residuum treated with alcohol, which dissolves the acetates, and leaves the nitre, the quantity of which may be easily calculated. If an alkali be present, it ought to be previously saturated with sulphuric or muriatic acid.

If nitre, common salt, nitrate of lime, and muriate of lime or magnesia, be present together, the water ought to be evaporated to dryness, and the dry mass treated with alcohol, which takes up the earthy salts. From the residuum, redissolved in water, the nitre may be separated, and calculated as in the last case. The alcoholic solution is to be evaporated to dryness, and the residuum redissolved in water. Let us suppose it to contain muriate of magnesia, nitrate of lime, and muriate of lime.—Precipitate the muriatic acid by nitrate of silver, which gives the proportion of muriate of magnesia and of lime. Separate the magnesia by means of carbonate of lime, and note its quantity. This gives the quantity of muriate of magnesia; and subtracting the muriatic acid, contained in that salt, from the whole acid indicated by the precipitate of silver, we have the proportion of muriate of lime. Lastly, saturate the lime added to precipitate the magnesia with nitric acid. Then precipitate the whole of the lime by sulphuric acid; and subtracting from the whole of the sulphate thus formed, that portion formed by the carbonate of lime added, and by the lime contained in the muriate, the residuum gives us the lime contained in the original nitrate; and 35 grains of lime form 100 of dry nitrate of lime.

ENGRAVING.

(Resumed from page 133.)

NEXT to the tools necessary, it is advisable to offer a few remarks upon the materials employed. The chief of these is, of course, the substance to be engraved upon, either copper or steel. Plates of these metals, of various sizes and thicknesses, are prepared ready for the engraver by persons who make it their sole employment; and those who are able to procure them thus prepared, will find it infinitely better to do so than to prepare the plates themselves; but should they live far off in the country, or for other reasons desire to prepare their own copper-plates, (for steel, they will, perhaps, not attempt,) the following observations may guide them:—Let them procure a sheet or piece of thick copper, the thickness (if a small plate) being about equal to that of a thin mill-board, or four cards pasted together. Let them carefully clean and polish both sides with sand, emery and water, or charcoal; wiping this off carefully that no grit may remain, let the plate be passed two or three times through a flatting mill, or wanting this, let it be planished by a tinman, directing him to keep it perfectly flat. When this is done, and the copper thereby hardened, let one surface be rubbed all over with a piece of *smoke* stone; a piece of *hone, fine slate*, or lithographic stone will do as well. When the plate is thus made smooth, and the inequalities of the hammer are removed, rub it over in the same manner with a piece of fine charcoal and oil; any bark, knot, or grit in the charcoal being first carefully rasped off it. Instead of charcoal fine washed emery may be used. Finally, the plate is smoothed around the edges with a plane or file, and polished with whitening. It will now be fit for use: a great deal of the success of the after operation will, however, depend upon the quality of the copper, as well as the preparation of it. Another method by which a plate may be made at once, is by the electrotype process. A plate, as a pattern, being first procured, another plate may be deposited upon that, which being removed, a second and a third plate in like manner may as easily be made, and if the operation has been well conducted, all will be of excellent quality, and cost but a trifle; (the whole process of the electrotype will be found in Vol. 1;) indeed thousands of plates are now made in London by this process.

The next material is *etching ground*. The use of it is to lay a ground upon the plate previous to etching it, as afterwards described. It may be bought along with the plates, or it may be made by the following receipt, and which, by experience, we know may be depended upon. The prescribed quantity will make enough to last for a long period, and cover a great number of plates:—Melt together 1 ounce of white wax, 1 ounce of asphaltum, and a quarter of an ounce each of common pitch and Burgundy pitch; let the whole boil ten minutes, then pour it into cold water, and mould it into a ball with the hands; when cold, tie it up in a piece of silk or taffeta.

Bordering wax is a substance used to form a ridge around the plate when it has been etched and is about to be bitten in by the acid. Its only use is to prevent the acid from running off at the edges of the plate; common shoe-makers' wax will do very well; so will glaziers' putty, though the following is most usually employed. As it is not wasted when in use, a stock of half a pound will last for years:—Melt together 2 ounces of rosin, 2 ounces of common pitch, and 4 ounces of yellow bees'-wax; when melted, pour the mixture into cold water, and as soon as it is sufficiently cooled, knead it well with the hands.

Acids required.—It is advisable in procuring a supply of acid for biting in, to choose the strong nitric acid, and not the common *aqua fortis;* strength for strength, it is but little dearer, and the engraver knowing the article he is operating with to be of first quality, can proceed with greater confidence. It should be diluted only when wanted, and in a degree according to the nature of the subject—this practice alone can teach.

Brunswick black varnish is purchaseable at most respectable oil shops. Its use to the engraver is to *stop out*, that is, to cover over false lines, and other defects, previous to biting in; and also during this part of the process, when a portion of the plate is bitten in enough, the rest of it requiring a further action of the acid. To be good, Brunswick black should dry in three or four minutes; it may be made by dissolving asphaltum in spirits of turpentine. If too thick at any time, it is to be diluted with spirits of turpentine. This liquid must therefore be in readiness, not only for the above, but other purposes, afterwards described. The Brunswick black varnish is to be laid on with a camel's-hair pencil.

A *wax taper* is the last material required. The intention of it is to smoke the ground of the plates, previous to transferring the picture which is to be etched upon them. The taper adapted to this purpose is that which is white, very long, and about the thickness of a goose quill, sold at oil-shops for 6*d*. Procure one of these tapers; if the weather be cold, soak it for a few minutes in luke-warm water, draw it out in length, wipe it dry, and fold it up or else cut it into eight equal pieces, which are to be twisted together, forming as it were a candle with eight wicks.

A *dabber* is also wanted; this may very easily be made by the artist, as it consists merely of a handful of wool or cotton wadding, tied up in a piece of silk; some persons put inside and behind the wadding a piece or two of stiff card, cut of a round form, in order to make the dabber keep its shape better, but this is by no means necessary. The dabber is used in the first process of laying the ground evenly upon the plate to be etched. It is, therefore, indispensable.

An *oil rubber* is made of a long strip of woollen cloth or flannel with the selvage to it. Take about two yards in length of this list, and roll it up tightly like a ribbon on its roller, so that the selvage shall form an even flat surface. Tie it tightly together and keep it for use; it is valuable in cleaning off a plate, after the scraper, burnisher and charcoal has been used upon it, it is rubbed over the part of the plate requisite, together with a little sweet oil.

The writing engravers, and those who execute mathematical engravings, often require little trifles in addition to the above, but as they are only of partial use, and not even absolutely necessary, we have not thought it requisite to mention them. These are, indeed, all the materials requisite for the most extensive business, costing, with the exception of the copper and steel plates, altogether, both tools and substances, not more than 6*s*. or 7*s*. The next paper will explain the process of etching.

Note—Copper and steel plates for engravers, and also etching ground, may be purchased of Mr. Hughes, Shoe Lane, London; or of Mrs. Large, Dean Street, Fetter Lane, London. A plate of copper the size of the smallest card, costs 3½*d*. Next size card, 7*d*. A plate about the size of one page of this book may be 3*s*. or 3*s*. 6*d*. The general price is 8*s*. ⅌ ℔ weight. Steel double the price. A ball of etching ground costs 1*s*. Engravers' tools may be bought of Mr. Knight, Foster Lane; Mr. Fenn and Mr. Buck, Newgate Street; and Mr. Holtzaffel, Charing Cross. Gravers are from 3*d*. to 6*d*. each; handles to ditto, 1*d*. A burnisher, 1*s*. Scraper, 3*s*. 6*d*. Etching needle, 6*d*. Sand cushions, of various prices—one costing 1*s*. is fit for ordinary occasions.

FLAT IRON WIRE ROPES.

Round iron wire ropes have for upwards of two years been successfully used in the collieries on the Continent. Another improvement in these ropes has been made, which will render them still more useful. M. Louis Goens, manufacturer at Termonde, in Belgium, has obtained a patent for *flat* iron wire ropes. This cordage, which resembles in a great degree flat hempen ropes, possesses extraordinary strength. When properly applied, it will last twice or three times as long as the ropes in present use, and yet the new rope costs a fifth less. Independently of these advantages the flat iron wire cord is more flexible, less bulky, and a great deal lighter than the ropes now used. The latter fact deserves the serious attention of mine proprietors especially, for a great quantity of power is now unprofitably employed in deep shafts in bringing up the weight of the rope alone. The first of these flat iron ropes manufactured by M. Goens, were applied by Messrs. Picard, Davignon, and Co., proprietors of the coal mine of La Bonne Fortune, near Ans, where they are now working, and give great satisfaction. Those gentlemen were the first mine proprietors who employed the round iron wire ropes.

POLARIZATION OF LIGHT.

To the Editor.

Sir.—In the interesting article on the polarization of light, recently published in your Magazine, there are two or three observations which have induced me to solicit further information; in doing so, I would remark that it is a subject to which I have given some attention, and that I have had considerable experience in the use of an oxy-hydrogen polariscope. I make these remarks that it may not be supposed that I ask idle questions, or that I seek information to be procured, by reading the ordinary treatises on the subject. In the article in question it is stated that a Nicol's prism is the best analyzing medium, and a drawing is given in illustration. I am fully aware that it is far superior to every other analyzing apparatus in ordinary experiment, but I cannot conceive how it is applied to the oxy-hydrogen polariscope.

Now what I would particularly ask is, *whether or not such an instrument has been constructed?* And if so, where can it be seen, or a particular description obtained?

It is also stated that polarization is best effected by reflection; but I have heard that oxy-hydrogen polariscopes are made by Carey, in the Strand, in which the light is polarized by transmission through a bundle of glass plates, and that the colors are more brilliant than those produced by the reflecting polariscopes. Can you inform me if this is correct?

Again, it is stated that the light is also analyzed by being transmitted through sixteen plates or films of mica; but this mica is not the mineral in its natural condition, it is prepared in some way before it is fit for experiment. Can you inform me in what way it is prepared? E. W.

Birmingham, August, 1841.

P.S.—Is the drawing (Fig. 1, page 113) made from an instrument, or is it a design for one? It is very unlike the instruments I have seen. Why is the light made to pass through three lenses?

[The article on the polarization of light we stated, in the commencement of it (see page 37), to be written by Mr. Goddard, the inventor of the polariscope afterwards described. The original will be found in a recent part of the "Transactions of the Society of Arts." A Nicol's prism is not mentioned in connection with the polariscope, but as explanatory of the general remarks which precede the description of that instrument. The polariscope has been constructed, and was used for a considerable time for public exhibition at "The Adelaide Gallery." Whether reflective or transmitting polariscopes, &c. are best, is a mere matter of opinion. The reason why two lenses are often combined to act as one in various optical instruments, is because the spherical and chromatic aberration of two lenses is one-fourth only of that produced by a single lens of the same focus; therefore Mr. Goddard has very judiciously doubled the lenses in the eye-piece of the instrument: the lens nearest the light is the better to concentrate the light upon the selenite or other polarizing medium. We regret that we do not know the preparation that mica undergoes, or if any, but from the nature of the substance we should think not.—ED.]

NOTES ON THE MONTH SEPTEMBER.

Weather at	*Average of the Thermometer.*	*Average of the Barometer.*	*Rain in Inches.*
LONDON	59 63	30 09	0·482
EDINBURGH....	54·3	29·739	3·470
DUBLIN	59·35	30·239	3·021

ANIMATED NATURE.

IN the early part of the month the Swallow sings, in the latter part of it it takes its departure to warmer climes. The other summer birds are also gone from us—broods of young Goldfinches appear—the Linnets congregate. Few winter birds visit us till the following month, yet we may see in September the Woodcock, the Fieldfare, and the Ring Ousel. The Stormy Petrel ventures further south than is her wont in brighter and milder weather; while many other sea birds change their habitation, the Sea Gulls—the Manx Puffin, and the Solan Goose. Owls are more noisy in this month than before. Many of the songsters of the spring resume their vernal notes, though with less brilliancy and constancy than at an earlier period. The note of the Woodlark is now in its greatest perfection. The Robin, who has been emphatically called the Brumal Songster, begins his sweet song on the approach of the cold. The insect race begins to feel the cessation of summer's heat; Butterflies and Moths are less abundant; the Bees, Ants, and Wasps more languid. Many Flies become blind and die; yet a few other tribes of insects abound still more than during the hot weather. The Earwigs are found in every garden, and the Spider's webs hang on every bush.

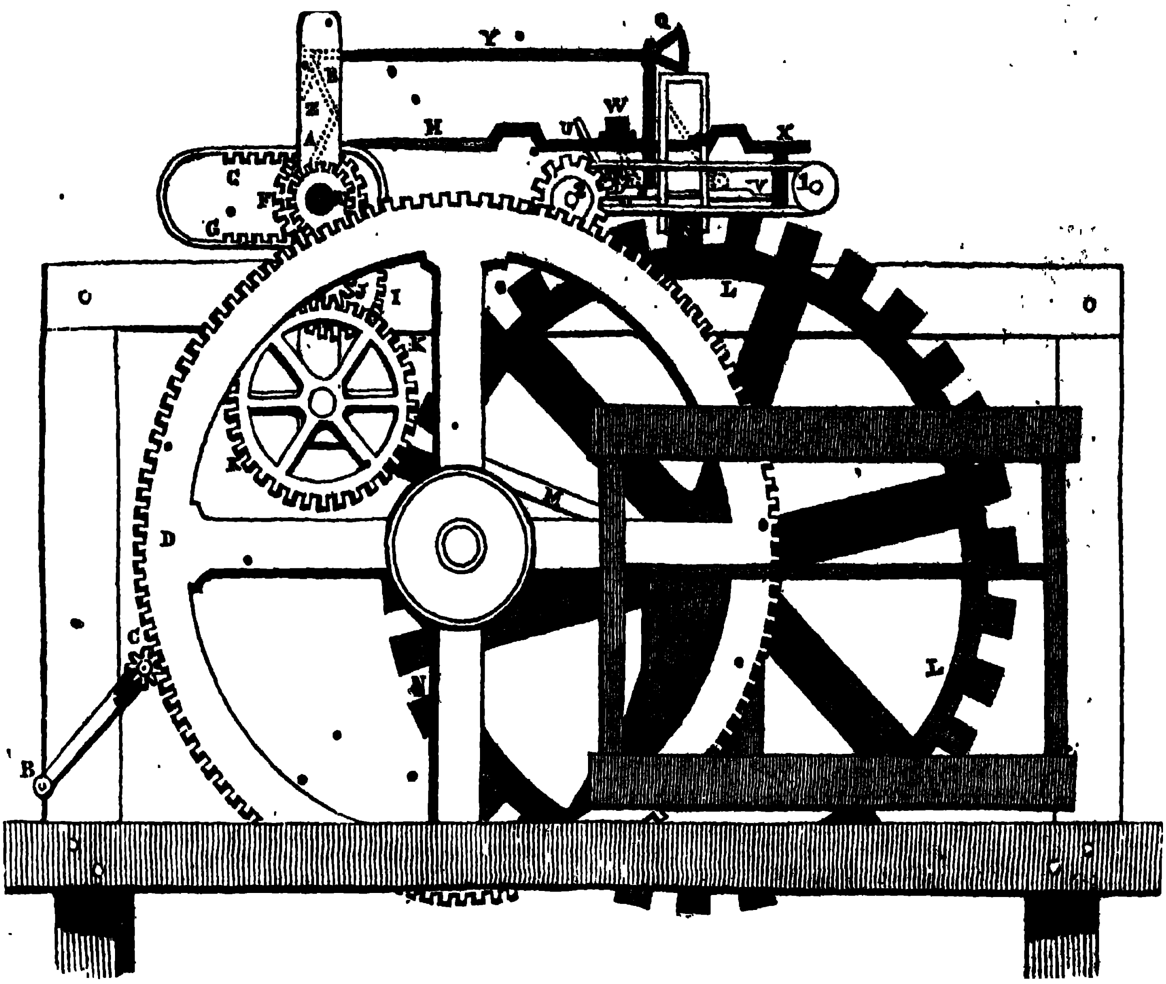
VEGETABLE KINGDOM.

This department of nature feels the effects of a declining and varying temperature, of heavy dews, and prolonged darkness. The gardens and the hedge-rows are still gay, but their gayness is of a different character. Red, white, and blue colors in flowers are much less abundant than at an earlier season, and yellow flowers take their place. By far the greater number of the compound flowers are yellow, and this is the season of their greatest abundance. The Hawkweed—the Marigold and the Aster are well known. The splendid Dahlia, (pronounced Dal-e-a, not Dale-e-a,) is now in full flower, and there are no less than a thousand varieties of it, of almost every color; a blue, a green, a brown, and a black excepted. Of native plants we may collect, among others, the Clematis vitalba, common in the chalky counties; Ballotta nigra, abundant in the south of England, but rare, if not unknown in Scotland—Parnassia palustris, a beautiful snow white mountain plant. The Ivy also is in flower, so are the Foxgloves—the tribe of the Mints—the Thyme—the Vervain, and the Arbutus. The trees put on their autumn tints, their fine green changes to the sickly yellow, or the gorgeous red; and intermingled as these colors often are, particularly in the Horse-chesnut, render by contrast the grove almost as beautiful as in the spring.

GARDENING OPERATIONS.

In the decline of the year, the chief occupation of the gardener is to gather his ripening crops, and to clear away the plants as they decay in the borders. It is hardly yet time to begin pruning and transplanting. Watering the borders will, on account of the dewy nights, be less necessary; but covering the melon beds in the evening, and taking care to close his conservatories, will require his attention. The cuttings of numerous shrubs may be planted out, and the seeds of many biennials sown, that they may blossom during the following year, such as columbine, agrimony, and chelone. Lawns and grassy glades should now be repaired where necessary; and towards the end of the month evergreens transplanted and pruned.

Fig. 2.



LEGGETT'S CHEMICAL COLOR PRINTING.

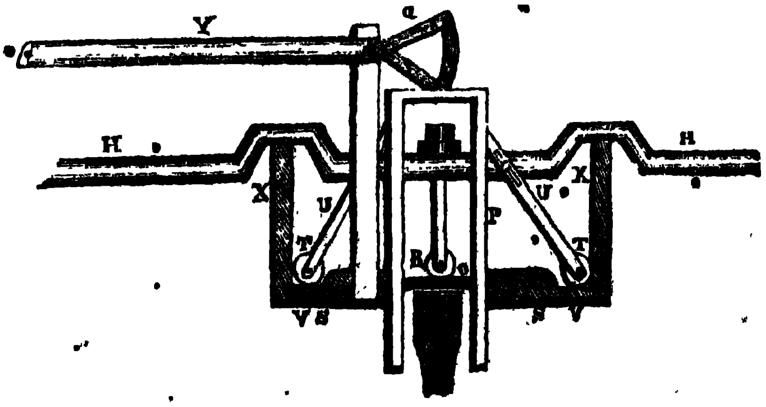


Fig. 1.

LEGGETT'S CHEMICAL COLOR PRINTING.

Most of us have admired the beautiful colored cards, show boards, and small articles of a similar description, which have appeared within this year or two in London, in which the colors are gradually softened into each other, and made to harmonize so exquisitely with each other. As the method by which such an effect is produced has puzzled many a one, and is besides a singular, a novel, and perfectly scientific application of chemistry, we are glad to accede to the request of several correspondents, and give the process entire; and to do this the more accurately, we avail ourselves of the words of the patent, and have besides figured the machinery described in it. It is the patent of Mr. Leggett.

“ This invention consists, first, in a new printing ink, to be applied to the purpose of printing in colors; to which the required color is given by certain chemical re-agents. Secondly,—In the mode of applying the said re-agents to prints or patterns, printed with the said ink. Thirdly,—Certain machinery for that purpose.

“ A quantity of logwood chips are boiled, for one hour, in eight times their weight of water, (soft water is best;) the liquor is then drawn off, and strained through a hair sieve. The chips are again boiled, for two hours, in another portion of water, of the same weight as the first, and the liquor is again drawn off and strained. The two decoctions are then mixed together, and a quantity of English verdigris, one-thirtieth the weight of the logwood chips, is mixed with water, to the consistence of cream; the whole, or part of it, is then poured gradually into the decoction, adding it till the coloring matter sinks to the bottom;—the precipitate being of a dark grey, or blue-black color, and the supernatant liquor is clear and colorless. The supernatant liquor is now drawn off by a syphon, and the precipitate is placed on a filter, made of fine cotton or woollen, in order to drain off and evaporate any moisture that may remain. When dry, it may be ground with oil, or any other liquid, according to the usual method of making printer's ink.

“ The print or pattern, whether on copper, steel, wood, or stone, is printed in the usual manner with this ink. Then, to those parts of the print or pattern, which, if it were a painting, would be colored yellow, is applied a weak solution of vegetable acid, or any acidulous salts, (bi-tartrate of potash, or tartaric acid, is best,) which will change the neutral grey of the ink to yellow. To those parts which are to be red or orange, a weak solution of vegetable acid, or any acidulous salts, is applied, (oxalic acid is best,) which will change the neutral grey of the ink to red or orange. To those parts intended to be pink or crimson is applied a solution of very dilute sulphuric, or other mineral acid, which will change the neutral grey of the ink to pink or crimson. To those parts which are to be colored lilac or violet is applied a solution of nitro-muriate of tin, or of alum, which will change the neutral grey of the ink to lilac or violet. To those parts which are to be blue, a solution of bi-carbonate of ammonia, or other alkali, is applied. To those parts which are intended to be purple, a dilute solution of bi-tartrate of potash, or other vegetable acid, is applied first, and afterwards a solution of the alkalies, above mentioned. If a very delicate pink is required, the ink may be made of Brazil chips, instead of logwood chips.

“ The chemical re-agents may be applied with a common hair pencil, or by either of the following processes, which constitute the second part of this invention:—

“ Blocks are formed, similar to those used by paper stainers, for printing silks, &c. A block being provided for each color, those parts of the drawing, which are required to be of the same color, are left in relief on the block set apart for that color; and blocks, being provided with the re-agents above mentioned, are applied in succession to the print or pattern. The following is the second of these processes: The print or pattern is copied on thin sheets of metal, paper, or other substance. A sheet of metal is provided for each color; and those parts which are required to be of the same color, are cut out with a graver, knife, or other instrument. The sheets are placed over the prints, and the re-agent is applied with a roller—a separate roller being provided for each re-agent. The roller is a cylindrical block of wood, covered with felt, of the kind commonly used for hatting-blocks; it is fastened to the block by small metal pins, or by dissolved shell-lac.

“ The third part of this invention is the machinery for applying the re-agents, which is equally applicable for original colors; and the patentee, in describing the machinery, uses the word ‘colors,’ in place of ‘re-agents.’

“ Fig. 1 shows the machinery, with the roller R, receiving color. Fig. 2, shows it passing over the metal plate. There is a platform, upon which the workman stands. B is a winch handle, that turns the pinion C, which is fastened on the working shaft. The pinion C turns the large wheel D. The teeth of this wheel take into the pinion E, and by this means the wheel F is turned. The wheel F works the rack G, by which the irregular rod H is moved. Another pinion is on the same axis as the pinion E, and the wheel F: which pinion has eight teeth, which are divided into sets of four, a space being left between each set; it turns the wheel I, by which means the pinion J, on the same axis, is also turned. The pinion J turns the toothed wheel K, which turns the large drum or narrow cylinder L, by the connecting rod M.

“ The prints or patterns to be colored are placed on the cogs N of the drum L. The metal plate O, (shown in Fig. 2,) is fastened to the frame P. This frame is raised by the quadrant Q, after the coloring roller R has passed over the metal plate, in order that a fresh cog may come under it; and during the time occupied in raising the frame P, the coloring roller is moved, (by the irregular rod H, to which it is attached,) on to one of the tables S, in order to take a fresh supply of color. The color is spread over the tables S, by the feeding rollers T T, which are moved backwards and forwards by studs on the irregular rod H, which work in the guides U of the feeding rollers. The feeding rollers take the color from the colors beds over V V.

“ It will be seen that the coloring roller R cannot descend so low as the metal plate, except when the raised parts of the irregular rod rest on the supports X; sufficient pressure is given to the coloring roller by the weight W.

“ The quadrant Q is worked by the rod Y, which rod is moved one way by the spring Z, and the other way by the lever A and B, which levers are moved by two tappets on the wheel F.

“ The coloring frame is supported by rods, provided with pins, which step into grooves in the rollers 1 and 2; motion being given to the roller 2, by a series of teeth, on the side of the large wheel D, taking into the teeth of that roller, and are so arranged that they commence acting on the teeth of the roller, as soon as the last of the series 4, quit the teeth of the pinion E. The motion is communicated from the roller 2, to the roller 1, by an endless cord."

EXTRACTING THE ORE IN LEAD MINES CONTAINING GOLD AND SILVER.

The beautiful experiments of M. Becquerel on the adaption of electro-chemical action to effect the separation of lead and silver in the galena, containing gold and silver, have demonstrated the possibility of applying electricity in the management of these mines. This valuable discovery has indeed been already adopted on a large scale by M. Becquerel, in the experimental manufactory that he has established at Paris; but, as is often the case in inventions of great importance, many years will probably elapse before his system is universally adopted in the working of lead mines containing silver. M. Becquerel observes, in reference to the method of extracting the metal at present pursued: As a proprietor of the auriferous and silver lead mines in the Duchy of Baden, I have carefully attended to the various processes that are generally adopted, and I am convinced of the possibility of obtaining a much greater produce from the mines by improving this process.

The observations that I have made, may be of some use to the lessees or proprietors of lead mines containing silver or gold. I will mention them in succession, pursuing in detail the method of working in the mines that I have superintended for ten years. Many of these mines are very rich in silver and gold.

First, as to the manner of washing the ore. By the manner in which the process is now executed, it is evident that a considerable quantity of the ore is lost, and the portion lost is that which is of the greatest value, the sulphuret of silver.

The gold and silver galenas have in general for their matrix a very hard quartz, in which are irregularly embedded sulphurets of silver, lead, iron, sulphate of barytes, or carbonate of iron, and also fluor spar. The variety of sulphurets that I have just enumerated contain gold, but in such a state of tenuity, that it is invisible in a microscope, and eludes every attempt to analyse it; yet gold does exist, since it is found in considerable quantity in assaying the silver. The ore broken into pieces of from two to five centimetres, falls by degrees into the trough in which the stampers work. A current of water passes through this trough, which is closed in front by a very close iron grating. The percussion of the stampers must be continued for a long time to reduce the ore sufficiently small to admit of its passing through the grating, and being carried into long canals called labyrinths, where it is deposited at a distance further or nearer in proportion to its size.

In attentively examining what takes place during the process of washing, it is remarked, that the fragments of ore, owing to the great hardness of the matrix resist the percussion of the stampers for a considerable length of time, and that they only very gradually diminish in size till they are completely broken. The ore thus successively reduced into minute pieces, is gradually carried away by the current of water beyond the labyrinth, where it ought to be deposited; and the loss of this part of the ore is more to be regretted, as the sulphuret of silver being very friable, it is the sulphuret that is first carried away; none remains but what is contained in those pieces of the ore, which, from their size and weight, have had power to resist the influence of the current.

I am well assured that the loss which I have just stated, is but too certain, as at the extremity of a labyrinth which reached for 200 metres, I took up water that was impregnated with the deposits of ore. This sediment, on being put to the test, yielded in the same weights a proportion of silver equal to that of the sediment in the water at the entrance of the labyrinth. The particles of gold disseminated in the sulphurets of lead, iron, and silver, not in a state of combination, but only united mechanically, escape in the same way.

Many ingenious men have in their writings indicated as a method of collecting the gold contained in minerals and in auriferous sands, the levigation of these very finely comminuted substances; but I cannot suppose that in this manner they imagine it possible to obtain the whole of the gold; this could only be done by means of chemical analysis. A very simple experiment will suffice to prove how very inefficient the levigation is for this purpose.

Take two discs formed of an alloy composed of lead, silver, and gold, and give them a circular motion against the surfaces of each other, by keeping them immersed in a vessel full of water. The water will very soon be rendered turbid and cloudy. If, in the same water, two discs of the mineral, in which the ores are imbedded (quartz for instance), are afterwards rubbed against each other, long enough to add new particles to those already contained in the fluid, all the metallic and earthy particles will not be settled till after eight days, and no trace will be perceived on the outer surface of the glass vase that the particles have been deposited according to their specific gravities. They will appear all mingled. Hence it may be concluded that when metals, ores, minerals, and sands in a state of extreme division are mixed, levigation is an ineffectual means of producing their complete separation.

The next operation to be considered is that of smelting the ores. The products of the mines are also greatly diminished at present by the loss of lead, silver, and gold, in the operation of smelting, in either reverberating or other furnaces generally used.

In the former case the roasting of the slag is a long and difficult operation, and with many ores almost impossible; those of Baden for instance, of which the matrix composed of quartz, of sulphate of barytes, and of fluor spar, is fusible to such a degree, that in making use of the reverberating furnace it would be necessary to smelt without previously roasting, and to let the first melting run out, which it would be necessary aftewards to calcine before re-smelting in another furnace, which must also be resorted to, to extract part of the refractory scoriæ. The losses in smelting are occasioned—

1st, By the volatilisation of a great quantity of sulphuret of lead, and sulphuret of silver, before their reduction.*

2d, By the action of the fluxes, and particularly by the silex on the lead at its different degrees of oxydation, from whence is produced the siliciates of lead which unite with the scoriæ.

3d, By the alkaline sulphurets and persulphurets, which, in a great degree, absorb the gold contained in the ore to be smelted.

4th, By the great quantity of fuel necessary to be used to retain in a state of constant fluidity the enormous proportion of the scoriæ of forges and furnaces obliged to be added to the melted ore, in order to secure the metal from being reduced by oxydation and volatilisation during the time it is passing into and remaining in the furnace, where I believe the temperature is raised to a much higher degree than is necessary.

5th, Finally, because, instead of obtaining by one smelting in which there is so great a consumption of combustible, the whole of the lead contained in the ore, only half of it is at first extracted, and the other half must be afterwards calcined, which is only an impure metal or sulphuret, in order to be smelted again.

I make no observation on the manner in which the operation of cupelling it is done at Baden, because I believe it is impossible to be managed better.

The consequence of the inconveniences that I have enumerated is, that though the produce arising from the gold and silver lead mines is quite equal to what might be expected in their present condition, it is yet capable of being considerably increased by improving the method of washing and smelting. —*Moniteur Industriel.*

SYSTEM OF EARTHENWARE PAVING.

BY M. POLONCEAU.

NOTWITHSTANDING the improvements that have at various times been introduced in the method of paving, the roadways of our high roads and the streets of our towns continue more or less uneven, which occasions those frequent jolts which are so destructive to carriages and horses. This state of the pavement is attributable to many causes, the principal of which are the general formation of the paving stones, the want of regularity in their surfaces, which does not admit of a good juxta-position, and the great difference in the hardness of the stones, which, although taken from the same quarry, are some of them worn out much sooner than others. This latter inconvenience exists not only with respect to the different kinds of stone regularly made use of, but also, and in a greater degree, with respect to vegetable substances, so that the method of paving in wood, which has been recently proposed, would, considered with reference to this, be inferior to stone pavement.

So long as stone pavements are used, M. Polonceau says it will be impossible to adopt any different form for the blocks than the one they have at present, which is that of a rectangular prism, for by substituting cutting for the common method of breaking, the expense would be considerably increased, while at the same time the resistance of the stone would be diminished in consequence of the repeated percussions.

The rectangular form is attended with the inconvenience of its being necessary that half the joinings should be placed in the same direction as the wheels, which are then compelled to follow them, and rub along the lateral ridges, enlarge the joinings, render the stones of the pavement round, and considerably increase the jolting. To remedy this inconvenience it has been attempted to place the paving stones diagonally, but the angles being then struck obliquely by the wheels the stones are broken and sink down yet more rapidly than they do in the usual method. Thus, in whatever manner the paving stones may be arranged, so long as they retain their rectangular prismatic shape, (and they cannot on an economical principle receive any other, as it is effected by merely breaking them,) the pavement will from the first be very uneven, and will become more and more so. It is in consequence of these considerations that M. Polonceau has been induced to make use of pavements of *earthenware*, to which in the course of manufacturing, and without any increase of expense, he gives the form likely to be the most durable. By means of plastic clay united with sands and cements, and pulverised charcoal, he succeeded in obtaining pieces of earthenware of considerable strength and size, which could be well dried without breaking, and bear exposure to a very great degree of heat without becoming vitrified or altered in shape. These pieces of earthenware are unpolished, and will strike fire with steel, resist blows as well as common paving stones, and are much less impermeable to moisture.

The pavements formed with this composition are six-sided prisms in the hexagonal form; the joinings are all either perpendicular or oblique to the motion of the wheels, and this without being subject to the inconvenience arising from having the paving stones placed diagonally; because the angles of the hexagon are stronger than those of the rectangle; and this advantage has been considerably augmented by reducing the sides of the prism by cutting a number of small ridges from three to four centimetres in size.

The only object in thus subdividing the surfaces of the blocks is to obtain more obtuse angles; but the triangular space which is the consequence of it is also useful as a receptacle for the bitumen with which these paving stones are cemented together.

Each paving block is perforated through the centre with a vertical hole, and on the outside there is a groove in which the bitumen lodges, which, by this means, is more effectual in rendering the different paving stones more firmly united, and in preventing them from sinking. In order to render this method of cementing more easy, the outsides of the paving blocks are cemented when they are taken out of the furnace, and before they are cold.

Great exactness of form can be readily given to the earthenware blocks. They are easily put together, and their joinings are so very close that the wheels can never be locked in them. Notwithstanding this absence of furrows, the *ceramique* pavement, as it is called by the inventor, is well adapted to horses, as the surface never becomes slippery. As it does not become round at the edges, there is much less liability to slip; besides the holes in the centre of the pavement, and the triangular cavities at the edges being filled with gravel mixed with bitumen, they form so many rests for the horses' feet.

The firmness of these pavements, M. Polonceau remarks, has given rise to one objection. It has been apprehended that it would be extremely difficult to make openings for the gas and water pipes; but the difficulty would be avoided by filling the vertical holes in the centre of the pavement with gravel without bitumen; it would be even quite sufficient if this precaution were only adopted at one of the two rows placed above the pipes, because the communication with the exterior would then be quite as easy as it is in the usual method of paving.—*Inventors' Advocate.*

MORDANTS FOR DYEING.

The term mordant, in dyeing and calico-printing, denotes a body which, having a two-fold attraction for organic fibres and coloring particles, serves as a bond of union between them, and thus gives fixity to dyes; or it signifies a substance which, by combining with coloring particles in the pores of textile filaments, renders them insoluble in hot soapy and weak alkaline solutions. In order properly to appreciate the utility and the true functions of mordants, we must bear in mind that coloring matters are peculiar compounds possessed of certain affinities, their distinctive characters being not to be either acid or alkaline, and yet to be capable of combining with many bodies, and especially with salifiable bases, and of receiving from each of them modifications in their color, solubility, and alterability. Organic coloring substances, when pure, have a very energetic attraction for certain bodies, feeble for others, and none at all for some. Among these immediate products of animal or vegetable life, some are soluble in pure water, and others become so only through peculiar agents. We may thus readily conceive, that whenever a dye-stuff possesses a certain affinity for the organic fibre, it will be able to become fixed on it, or to dye it without the intervention of mordants, if it be insoluble by itself in water, which, in fact, is the case with the coloring matters of safflower, annotto, and indigo. The first two are soluble in alkalis; hence, in order to use them, they need only be dissolved in a weak alkaline lye, be thus applied to the stuffs, and then have their tinctorial substance precipitated within their pores, by abstracting their solvent alkali with an acid. The coloring matter, at the instant of ceasing to be liquid, is in an extremely divided state, and is in contact with the organic fibres for which it has a certain affinity. It, therefore, unites with them, and, being naturally insoluble in water, that is, having no affinity for this vehicle, the subsequent washings have no effect upon the dye. The same thing may be said of indigo, although its solubility in the dye-bath does not depend upon a similar cause, but is due to a modification of its constituent elements, in consequence of which it becomes soluble in alkalis. Stuffs plunged into this indigo bath get impregnated with the solution, so that when again exposed to the air, the dyeing substance resumes at once its primitive color and solubility, and washing can carry off only the portions in excess above the intimate combination, or which are merely deposited upon the surface of the stuff.

Such is the result with insoluble coloring matters; but for those which are soluble it should be quite the reverse, since they do not possess an affinity for the organic fibres which can counterbalance their affinity for water. In such circumstances, the dyer must have recourse to intermediate bodies, which add their affinity for the coloring matter to that possessed by the particles of the stuff, and increase by this two-fold action the intimacy and the stability of the combination. These intermediate bodies are the true *mordants.*

Mordants are in general found among the metallic bases or oxydes; whence they might be supposed to be very numerous, like the metals; but as they must unite the two-fold condition of possessing a strong affinity for both the coloring matter and the organic fibre, and as the insoluble bases are almost the only ones fit to form insoluble combinations, we may thus perceive that their number may be very limited. It is well known, that although lime and magnesia, for example, have a considerable affinity for coloring particles, and form insoluble compounds with them, yet they cannot be employed as mordants, because they possess no affinity for the textile fibres.

Experience has proved, that of all the bases, those which succeed best as mordants are alumina, tin, and oxyde of iron; the first two of which, being naturally white, are the only ones which can be employed for preserving to the color its original tint, at least without much variation. But whenever the mordant is itself colored, it will cause the dye to take a compound color quite different from its own. If, as is usually said, the mordant enters into a real chemical union with the stuff to be dyed, the application of the mordant should obviously be made in such circumstances as are known to be most favorable to the combination taking place;—and this is the principle of every day's practice in the dye-house.

In order that a combination may result between two bodies, they must not only be in contact, but they must be reduced to their ultimate molecules. The mordants that are to be united with stuffs are, as we have seen, insoluble of themselves, for which reason their particles must be divided by solution in an appropriate vehicle. Now this solvent or menstruum will exert in its own favor an affinity for the mordant, which will prove to that extent an obstacle to its attraction for the stuff. Hence we must select such solvents as have a weaker affinity for the mordants than the mordants have for the stuffs. Of all the acids which can be employed to dissolve alumina, for example, vinegar is the one which will retain it with least energy, for which reason the acetate of alumina is now generally substituted for alum, because the acetic acid gives up the alumina with such readiness, that mere elevation of temperature is sufficient to effect the separation of these two substances. Before this substitution of the acetate, alum alone was employed; but without knowing the true reason, all the French dyers preferred the alum of Rome, simply regarding it to be the purest; it is only within these few years that they have understood the real grounds of this preference. This alum has not, in fact, the same composition as the alums of France, England, and Germany, but it consists chiefly of cubic alum having a larger proportion of base. Now this extra portion of base is held by the sulphuric acid more feebly than the rest, and hence is more readily detached in the form of a mordant. Nay, when a solution of cubic alum is heated, this redundant alumina falls down in the state of a subsulphate, long before it reaches the boiling point. This difference had not, however, been recognized, because Roman alum, being usually soiled with ochre on the surface, gives a turbid solution, whereby the precipitate of subsulphate of alumina escaped observation. When the liquid was filtered, and crystallized afresh, common octahedral alum alone was obtained; whence it was most erroneously concluded, that the preference given to Roman alum was unjustifiable, and that its only superiority was in being freer from iron.

The two principal conditions, namely, extreme tenuity of particles, and liberty of action, being found in a mordant, its operation is certain. But as the combination to be effected is merely the result of a play of affinity between the solvent and the stuff to be dyed, a sort of partition must take place, proportioned to the mass of the solvent, as well as to its attractive force. Hence the stuff will retain more of the mordant when its solution is more concentrated, that is, when the base diffused through it is not so much protected by a large mass of menstruum; a fact applied to very valuable uses by the practical man. On impregnating in calico printing, for example, different spots of the same web with the same mordant in different degrees of concentration, there is obtained in the dye-bath a depth of color upon these spots intense in proportion to the strength of their various mordants. Thus, with solution of acetate of alumina in different grades of density, and with madder, every shade can be produced, from the fullest red to the lightest pink;—and, with acetate of iron and madder, every shade from black to pale violet.

INEXPLICABLE PHENOMENA OF UNANNEALED GLASS.

We have long been accustomed to regard the phenomena which precede and attend the fracture of unannealed glass, as some of the most remarkable and inexplicable of all the manifold secrets of nature. Many other phenomena, although curious, might have been predicated after mature reflection, as they are in strict accordance with the known laws of nature; but we think we may confidently assert, that no man, how skilled soever he might be in chemistry, or any other department of natural philosophy, could have predicted the effect produced upon unannealed glass by the most apparently insignificant and inadequate cause. If any philosopher or chemist, for instance, had been asked what would be the consequence of dropping a few grains of light sand into a goblet of glass not properly annealed, he would never have guessed that the effect would be to shiver the tumbler into atoms. As it is possible that some of our readers may not understand what is precisely meant by unannealed glass, it may be proper here briefly to explain the term.

When glass, from the melting-pot, is fashioned into tumblers, bottles, &c., it is gradually cooled by being removed successively from a higher to a lower temperature, which process is termed annealing. When this gradual process is neglected, the most extraordinary results are found to take place. What are called Prince Rupert's drops are an excellent and familiar illustration of the anomalous phenomena under consideration. They are formed simply by dropping a little melted glass into cold water, when it suddenly collapses into a small pear-shaped drop, with a slender thread-like tail or extremity. If the thick end of the drop be held in the hand, and the small end be broken off, the whole of the glass will fly into shivers, imparting to the hand a smart shock, similar to that from an electrical jar. What is equally singular is, that if Rupert's drops, instead of being broken in the manner described, be thrown down forcibly upon flags, they will recoil by their elasticity, but they will not be broken, how violently soever they be brought into contact with the flags

We have now to notice another of the numerous phenomena exhibited by unannealed glass, which is not so generally known as that of the Rupert's drop, but which is equally inexplicable. It was communicated to us several months ago, by the correspondent whose note we here subjoin, with a few comments appended to it:—

"Sir.—Allow me, then, to detail a curious accident which happened under my own hands, with a glass tube, and which has occurred to several others, to whom I have mentioned it. Some short time ago I procured a glass tube for the purpose of constructing a barometer. After cleaning it well with an *iron wire*, tipped with wash leather, I placed it upon a table, and was astonished to find, in a quarter of an hour, the tube broken into several pieces. On mentioning it to a friend he immediately pronounced it to be caused by the wire, as he had had a similar accident. Not being satisfied that it could be produced by the wire, I placed another tube with a bit of wire in it, and was surprised to find, that, in a short time, the tube broke into several pieces. I cannot account for the phenomena, neither is the fact noticed in any scientific treatises with which I am acquainted. Barometer makers seem to be aware of it, and never use wire in cleaning their tubes."

The phenomenon, which is the subject of our correspondent's letter, is familiar to the barometer makers, who, in cleaning out the interior of the tubes, take especial care that the iron wire employed for the purpose shall not touch the glass, as the contact of the two substances is almost uniformly followed by a fracture of the glass, not immediately, but after a short interval. This is one of the most extraordinary circumstances of the phenomenon; as it is difficult, if not impossible, to form any rational explanation of the secret mysterious operation which must be going on in the tube, between the moment of contact with the wire and the subsequent fracture. If, as there is reason to conclude, the momentary contact of the wire with the glass produce the fracture, why does it not instantly take place? There appears to be an effect, without an adequate or intelligible cause. It seems that this kind of phenomenon is not altogether confined to glass, but occasionally occurs in cast metal, probably from its sudden cooling, or from not having been properly annealed. However that may be, it is a fact that the metal of which the mirrors of reflecting telescopes are constructed, is very apt to fly to pieces by the slightest scratch, just like the barometer tubes, in consequence of their coming in contact with the iron rod used to clean out the inside.

In conclusion, we may observe, that the phenomenon of the barometer tubes, noticed by our correspondent, is to be ascribed, no doubt, to their imperfect annealing; and that the remedy for the defect would be that pointed out by Mr. Pellatt, of London, at a late scientific meeting, from the report of which we transcribe the following passage:—

"Mr. Pellatt recommended boiling as a safe and good mode of annealing all kinds of glass. In the ordinary method of annealing, thick and thin ware is often subjected to the same process, and remains in the leer for the same period; this would account for the superior duration of the thin tubes. He attributed the fracture of the tubes to the tension of the exterior coating and the vibration caused by the process of cleaning; this effect was so well known that an old tube could scarcely be sold, as it generally broke in cleaning."—*Liverpool Mercury.*

IMPREGNATION OF WATER WITH OXYGEN.

The very ingenious but laborious plan of effecting this curious purpose is related by M. Thenard in the eleventh volume of the *Annales de Chimie et de Physique*: from thence the detail of the necessary experiments was translated into the English journals as follows :—

"The preparation of oxygenated water requires certain precautions, without which success will only be partial. That none may be omitted, I shall describe the process in the most minute manner.

"1. Nitrate of barytes should first be obtained perfectly pure, and above all, free from iron and manganese. The most certain means of procuring it is, to dissolve the nitrate in water, to add to the solution a small excess of barytes water, to filter and crystallise.

"2. The pure nitrate is to be decomposed by heat. This ought not to be done in a common earthenware retort, because it contains too much of the oxydes of iron and manganese, but in a perfectly white porcelain retort. Four or five pounds of nitrate of barytes may be decomposed at once, and the process will require about three hours. The barytes thus obtained, will contain a considerable quantity of silex and alumine, but it will have only very minute traces of manganese and iron, a circumstance of essential importance.

"3. The barytes, divided by a knife into pieces as large as the end of the thumb, should then be placed in a luted tube of glass. This tube should be long, and large enough to contain from 2 lbs. to 3 lbs. It is to be surrounded with fire, and heated to dull redness, and then a current of dry oxygen gas is to be passed through it. However rapid the current, the gas is completely absorbed; so that when it passes by the small tube which ought to terminate the larger one, it may be concluded that the deutoxyde of barium is formed. It is, however, well to continue the current for seven or eight minutes more. Then the tube being nearly cold, the deutoxyde, which is of a light grey color, is taken out, and preserved in stoppered bottles.

"4. A certain quantity of water, for example, four pints, is then taken; to which is added as much pure and fuming hydrochloric acid as will dissolve 200 grains of barytes. The acid solution is put into a glass with a foot, and ice placed round it, which must be renewed as it melts. Then 180 grains of the deutoxyde are to be very slightly moistened, and rubbed by portions in a mortar of agate or glass. As these portions are reduced into a fine paste, they are to be removed by a box-wood knife, and placed in the fluid; they will soon dissolve without effervescence, especially if slightly agitated. When the solution is made, pure and concentrated sulphuric acid is added, drop by drop, the fluid being stirred at the time with a glass rod, until there is a slight excess of it, which is easily known by the property possessed by the sulphate of barytes formed at the moment, of readily depositing in flocculi; then, as at first, a fresh quantity of deutoxyde is dissolved in the fluid, which is again precipitated by sulphuric acid. The deutoxyde is always easy to distinguish from the sulphate. It is important to add enough sulphuric acid to precipitate all the barytes, but not too much. If enough is not added, the fluid filters with difficulty, and slowly; if too much is added, the filtration also goes on badly. On arriving at the exact point mentioned, the filtration takes place with the utmost facility. When the filtration is completed, a small quantity of common water is to be passed through the filter, and added to the first fluid; in this way the latter does not lose in volumn: then, that nothing may be lost, it is necessary to spread the filter on a glass plate, to separate the substance from it, diffuse it through a small quantity of fresh water, and filter it. The water thus obtained is but slightly charged, but it is useful to wash the future filters.

"This operation being finished, another is made exactly similar to it, *i. e.* deutoxyde of barium is to be dissolved in the fluid; the barytes is to be precipitated by sulphuric acid, and so on; and the fluid is not to be filtered until after two solutions and two precipitations. It is on this new filter that the water obtained by washing the precipitate in the preceding operation is to be poured; after which fresh weak water is procured by washing the matter on the last filter.

"The second operation is followed by a third, that by a fourth, and thus, until the fluid is sufficiently charged with oxygen. By using the quantity of hydro-chloric acid mentioned, 30 ounces of deutoxyde of barium may be operated on, and a fluid will be obtained charged with 25 or 30 times its volumn of oxygen. If it is required to be further oxygenized, more hydro-chloric acid must be added.

"I have many times succeeded by this means in charging the fluid with 125 times its volumn of oxygen, but I added acid enough to dissolve 463 grains of the deutoxyde, being careful also to preserve the acidity such, that at the end of the operation I could dissolve about 309 grains of the deutoxyde, without the aid of sulphuric acid; but I have ascertained that when the fluid contains nearly 50 volumns of oxygen, it allows so much gas to escape from one day to the next, that there is no advantage in continuing to oxygenate it by the deutoxyde.

"5. When the fluid is oxygenated up to the required point, it is to be saturated with deutoxyde, retaining it at the same time in ice. Abundant flocculi of silex and alumine soon separate from it, which are generally colored yellowish-brown, by a little of the oxydes of iron and manganese. The whole should then be thrown quickly on a cloth, inclosed in it, and strongly compressed. This operation cannot be done well except by two persons, and should be performed rapidly; for though there is but a very minute quantity of oxyde of manganese, it is sufficient to produce a considerable disengagement of oxygen.

"6. As the fluid which has passed the cloth may still retain a small quantity of silex, iron, and manganese, and as it is necessary to separate all these substances, it is again to be surrounded by ice, and barytes water added to it, drop by drop, the whole being stirred. If, when the barytes is in such excess as to be slightly sensible to colored paper, there is no precipitate, it proves that all the oxyde of iron and manganese are separated; if they have not been completely separated in the preceding operation they will by this

(To be continued.

MEDICAL RECEIPTS, &c.

Guestonian Embrocation.—Take 1½ ounce each of olive oil and oil of turpentine, 3 ounces of dilute sulphuric acid; mix, and apply to the surface of rheumatic joints, &c.

Grey Lotion is prepared by adding variable proportions; according to the case, of chloride of mercury to lime water. Used for soothing irritable sores.

Harrowgate Water, imitated by dissolving 5 grains of sulphuret of potass in a glass of soft water.

Heading for Beer.—It is not known well upon what principle, but the fact is certain, that sulphate of iron (*Green Copperas*) added to beer makes it carry a head, or froth, though it be weak. The stuff, sold under the name of *heading*, consists of a mixture of alum and sulphate of iron.

Henry's Aromatic Vinegar is an acetic solution of camphor, and of oil of cloves, lavender, and rosemary. *Imitated* by putting 1 dram of acetate of potass into a phial with a few drops of any fragrant oil and 20 drops of sulphuric acid.

Hippocras is prepared by macerating for seven days 6 pints each of Madeira and Canary, with 1 ounce of cinnamon, 2 drams of canella, and ½ dram each of cloves, nutmeg, mace, ginger, and cardamoms. Strain and add ¼ pound of refined sugar.

Honey Water.—Is prepared with 1 gallon of Cognac brandy, 1 pound each of virgin honey and coriander seeds, 1½ ounce of cloves, 1 ounce each of nutmegs, benzoin, and storax, four vanilloes, and the rind of three large lemons. Digest for two days, and distil with a gentle heat. Add to every gallon of the water, thus procured, a pint and a half each of orange-flower water, and rose water, and 5 grains each of musk and ambergris. Digest again for three days in a gentle heat; filter and keep in a well-stopped bottle. Several other receipts are in use, but they do not differ much from this. *Imitated* by mixing fragrant essences, coloring them with saffron, and thickening them with honey; or take 2 pounds each of rose water and of orange-flower water, ½ ounce of oil of cloves, 2 ounces of essence of bergamot, ½ ounce of oil of lavender, 16 grains of musk, 1 gallon of spirits of wine, and color with saffron.

Hooper's Pills.—Take 1½ pound of aloes, 2 ounces of myrrh, ¼ pound each of carbonate of iron and of sulphate of iron, add also a little canella bark and ivory-black. Make into a mass, and divide into four-grain pills.

Huiles Antiques are chiefly composed of oil of ben, or oil of hazel, which having no smell of its own is ready to imbibe any other odour with which it may be combined. They are often, however, made with olive oil.

Huile Antique à l'Orange.—With 1 pound of oil of ben, mix 3 ounces of essential oil of orange, and put it into small bottles, well corked, with wax over them to preserve it from the air, and prevent the perfume of the orange oil from evaporating.

Huile Antique à la Rose.—Procure a tin, or white iron box, about a foot square, opening by a grating on one side, and divided in the middle by a partition of white iron, drilled full of small holes, close to each other. Fold in four a cotton towel, soak it in oil of ben, and place it on the grating so as to exactly fit the box. Upon this cloth place rose-leaves, fresh gathered, leave them for about 24 hours, and then replace them with fresh rose-leaves. The cloth may then be removed, and the oil, now charged with the perfume, carefully expressed.—This may be mixed with fresh oil of ben, and bottled for use.

In the same manner may be made *Huiles Antiques à la Fleur d'Orange, à la Violette, à la Jonquille, au Jasmin, &c.*, and by means of various mixtures—*à l' Héliotrope, aux Mille Fleurs, au Pot-pourri, &c.*

Huile Antique à la Tuberose.—Mix the flowers with ground blanched bitter almonds, and then express the oil; or mix a pint of olive or almond oil with 30 drops of the essence of tuberose flowers. In this way also several of the above *Huiles Antiques* can be prepared.

Isinglass Mucilage.—A vehicle for water colors, invented by Mr. Robertson, of Worton Lodge. It is prepared by macerating shreds of good isinglass in water till thoroughly soft, dissolving these in boiling alcohol, so that a compound fluid be produced when cold. It gives water-color paintings great power and permanence.

James's Analeptic Pills.—The original receipt is: Take 1 dram each of James's powder, Rufus's pill mass, and gum guaiac; make a mass with tincture of castor, and divide into 40 pills. They are usually made, however, with compound antimonial powder, instead of James's powder.

James's Powder.—This celebrated nostrum was analysed by Dr. G. Pearson, and found to contain 57 parts of oxide of antimony, partly vitrified, and 43 parts of phosphate of lime. Mr. R. Phillips has lately found the proportions of these to be 56 and 44. The original specification of James is:—"Take antimony, calcine it with a continued protracted heat, in a flat unglazed vessel, adding to it from time to time a sufficient quantity of any animal oil or salt, dephlegmated; then boil it in melted nitre for a considerable time, and separate the powder from the nitre by dissolving it in water." This, however, is a false receipt, as it will not produce the powder. That there is a regular and certain process for its preparation, is proved by the similarity of the two analyses by Pearson and Phillips at a considerable distance of time.

Jesuit's Drops are compound tincture of benzoin, or compound tincture of copaiba, made with 1 ounce of gum guaiac, 2 ounces of copaiba, 2 drams of oil of sassafras, and ½ pint of alcohol.

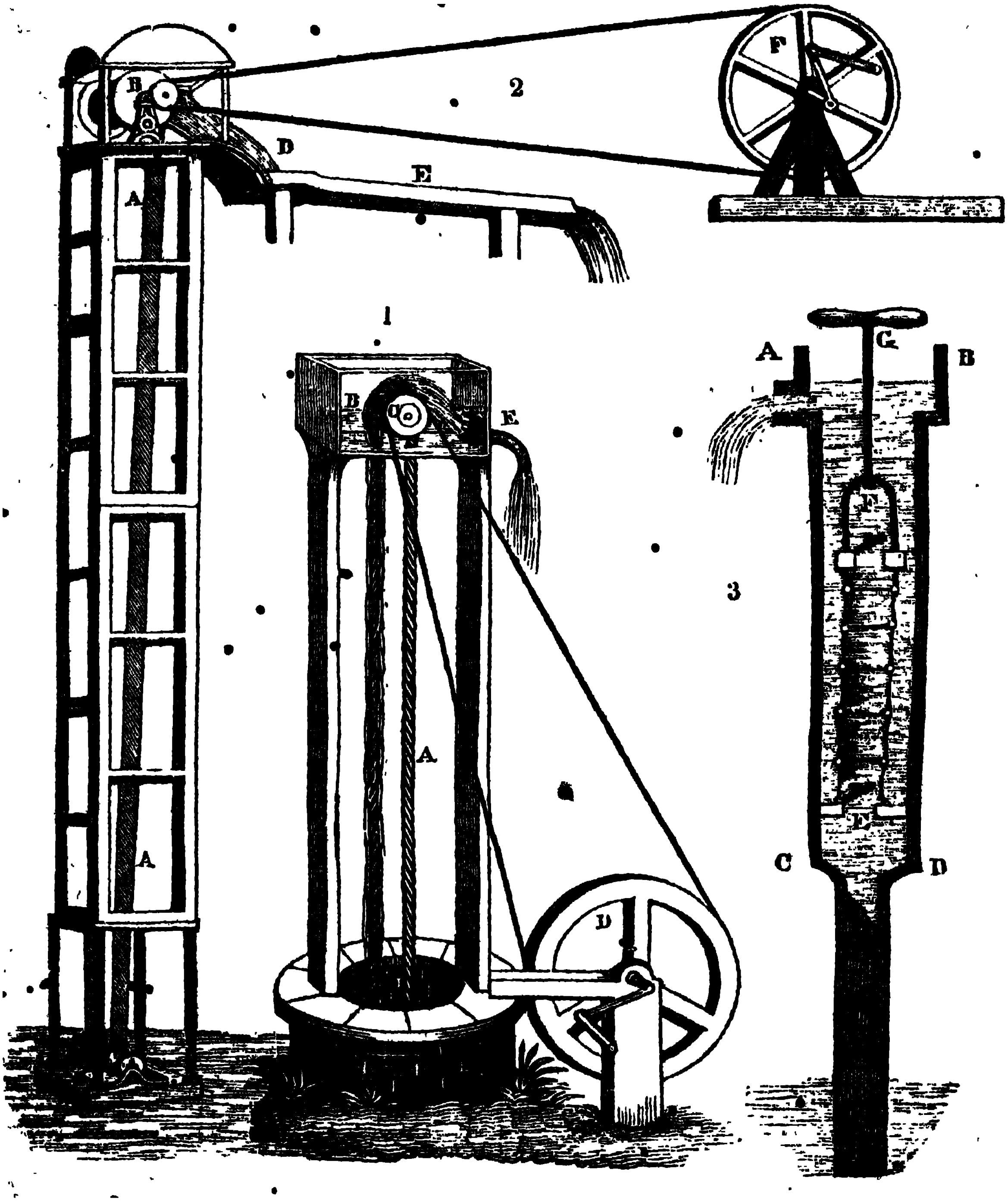
Kermes Mineral, an antimonial medicine still in great repute on the Continent. It is prepared by boiling for an hour one part of carbonate of potass, with four parts of native sesqui-sulphuret of antimony finely pulverized in a quantity of water, filtering and setting the liquor aside to cool, the precipitate of which is the kermes.

Keyser's Pills, Dragés de Keyser.—A foreign nostrum composed of acetate of mercury and manna, and reputed to be antisyphilitic.

Knox's Disinfecting Powder.—Mix eight parts of chlorinated soda with three parts of chlorinated lime. An ounce of this dissolved in a tumbler of water is similar to Labarraque's liquid.

Lardner's Prepared Charcoal.—Triturate chalk with charcoal or ivory black.

Lignum's Antiscorbutic Drops consist of a disguised preparation of bichloride of mercury. The proprietor's name was originally *Wood*, which he thought it advantageous to translate into Latin.



HYDRAULIC MACHINES.

HYDRAULIC MACHINES.

We give illustrations upon the present occasion of two or three little known, yet very valuable hydraulic instruments; one of them, namely, the rope pump, has been known for a very long period, and, after remaining too long disregarded, has been lately re-invented or re-introduced under the name of Hall's hydraulic belt—we give engravings of both, that they may be compared. The hydraulic belt (No. 1,) is, with the exception of the pipe that conveys away the water raised, the representation of that exhibited at the Polytechnic Institution, London; the other (No. 2,) is from Walker's "Elements of Natural Philosophy."

The *rope pump* is an instrument for raising water by means of a loosely-spun rope, which dips into the water of the well, and being put into a rapid motion, the water, adherent to the rope, acquires a certain momentum—that is, a force or power of continuing itself in motion, notwithstanding the effect of gravitation, which acts in drawing it down again; or in other words, it acquires, in consequence of the very rapid motion of the rope, a very considerable centrifugal force, so as to overcome the antagonist force, the centripetal, or the tendency to fall downwards. This centrifugal force or momentum will continually increase according as the water rises, because the force it continually receives from the motion of the rope is not lost, but on the contrary, as soon as it exceeds the centripetal force, which is as soon as the water rises at all, the excess of the two forces is continually accumulating, and forming a momentum, which carries the water onwards. So evidently is this the case, that when the water arrives at the cistern above the upper end of the rope, its direction being suddenly changed, the water flows upwards and forwards with considerable force. Taking this, then, as an explanation of the mode of action of this and similar machines, it may be thought that water may be carried to any height; this is not exactly the case, for two reasons—one is, the power required increasing as the weight of the whole body of water increases, and that multiplied by the height it is to be raised; and secondly, from the circumstance that there are always particles of the fluid being detached from the column of water, and these, when no longer partaking of the impulse continually given by the rope, soon lose whatever momentum they may have acquired, and fall again into the reservoir at the bottom. With this last cause of failure constantly occurring, and a recollection that there is no chain of buckets or paternoster work to assist in raising the water, it is astonishing what a vast quantity may be raised to a considerable height, and with the expenditure of very little power. The structure of the rope pump is so simple that to see a figure of it is tantamount to understanding it; it is represented in Fig. 2, where the letter A shows the rope raising the water from the well. It passes at the lower end under a spindle or axis, and at the upper end over a similar axis B, forming an endless rope, the two ends being spliced together. The upper axis has a pulley attached, over which passes another endless rope C, leading to the large wheel below. As soon as a person turns the large wheel by the winch attached to it, he, of course, puts not merely its own cord in motion, but also the rest of the moveable parts of the machine, the water rope and its two axes; supposing, therefore, that the lower one dips into the water of the well, it will be raised, owing to the causes we have previously explained, and flow into the cistern above, whence it may be conveyed as required. The reason that it does not descend again with the rope is that this latter, passing upwards, has to go through a large hole in the cistern, that the water may not be impeded in its ascent, but as soon as it turns over, it passes through a pipe only large enough to admit the rope itself, therefore the water not already thrown off by centrifugal force, is, as it were, scraped from the rope, and falling into the cistern is also carried away.

The *patent hydraulic belt*, or water elevator of Mr. Hall, differs in no respect in principle from the above, the difference consisting in the substitution of a wide belt instead of a rope; it thereby is enabled to raise a larger quantity of water within a given time. In the cut No. 1, A is the hydraulic belt, B the roller, over which the belt revolves; C the bottom roller, under the surface of the water; D water discharged on passing over the roller; E shoot to receive the water raised; F wheel by which the whole is put in motion.

The other figure (3) is not given as a representation of any machine similar in structure to either of the above, but as one of a pump as little known, and which has been as much neglected as the rope pump, although one which is very effective in raising a large quantity of water to small heights, and which, like the others, may be made by any carpenter, without the assistance of the plumber or pump-maker. A B C D, Fig. 3, is a square trunk of carpenter's work, open at both ends, and having a little cistern and spout at top. We have also represented it as with a long pipe at bottom, but this is not always necessary. Near the bottom of the square trunk is a partition of wood, perforated with a pole E, and covered with a common clack valve or dock as it is called. Above this is a long cylindrical bag made of leather or of double canvass, with a fold of thin leather, such as sheep-skin, between the canvass bags. This is firmly nailed to the board E with soft leather between. The upper end of this bag is fixed on a round board having a hole and valve. This board may be turned in the lathe with a groove round its edge, and the bag fastened to it by a cord bound tight round it. The fork of the piston-rod F G is firmly fixed into this board; the bag is kept distended by a number of wooden hoops or rings of strong wire, put into it at a few inches distance from each other. It will be proper to connect these hoops, before putting them in, by three or four cords from top to bottom, which will keep them at their proper distances. Thus will the bag have the form of a barber's powder-puff. The distance between the hoops should be about twice the breadth of the rim of the wooden ring to which the upper valve and piston-rod are fixed.

Now let this trunk be immersed in the water. It is evident that if the bag be stretched from the compressed form which its own weight will give it by drawing up the piston-rod, its capacity will be enlarged, the valve E will be shut by its own weight, the air in the bag will be rarefied, and the atmosphere will press the water into the bag. When the rod is thrust down again, this water will come out by the valve E, and fill part of the trunk. A repetition of the operation will have a similar effect; the trunk will be filled, and the water will at last be discharged by the spout.

Here is a pump almost divested of friction, and perfectly light; for the leather between the folds of canvass renders the bag impervious both to air and water; and the canvass has very considerable strength. We know, from experience, that a bag of six inches diameter, made of sail-cloth, No. 3, with a sheep-skin between, will bear a column of fifteen feet of water, and six hours work per day for a month without failure, and that the pump is considerably superior in effect to a common pump of the same dimensions. We must only observe, that the length of the bag must be three times the intended length of the stroke; so that when the piston-rod is in its highest position, the angles or ridges of the bag may be pretty acute. If the bag be more stretched than this, the force which must be exerted by the laborer becomes much greater than the weight of the column of water which he is raising. If the pump be laid aslope, which is very usual in these occasional and hasty drawings, it is necessary to make a guide for the piston-rod within the trunk, that the bag may play up and down without rubbing on the sides, which would quickly wear it out.

YOUNG AND DELCAMBRE'S COMPOSING MACHINE.

Those who are at all acquainted with the printing business, and know that every letter of every word is a separate piece of metal, and must be taken up separately by the compositor, then turned the face upwards, and the proper part of the letter to the top of the page, will scarcely believe it possible that a machine could be constructed, which will of itself accomplish all this, and with facility—yet such an one is now in operation, and may be seen at 110, Chancery Lane, London. We refrain from giving the details of its construction, because the ingenious inventor proposes some great improvements in and simplification of some of the parts; and until these are effected, we should necessarily have to describe a less perfect instrument than we hope shortly to be enabled to introduce; from drawings and description which we have kindly been promised by Mr. Young, the inventor. The principle upon which the machine acts, we may, however, as well state. It is this:—There are a number of long troughs put in nearly a vertical position, one for each kind of letter or other character. These are filled with the type to be used; at the bottom of each is a stud or key, with the character of the letter upon it, A B C, and so on. Upon pressing down this stud, a letter is let fall out of the trough attached to it. It slides down an inclined plane, and deposits itself horizontally in a long groove prepared to receive it. Other letters succeed, according to the keys which are pressed upon, and rest upon the former, until a line of letters is formed, 2 feet or more in length. This line of letters is taken away, and a second trough substituted and filled as at first. The long line of letters taken away is *justified*; that is, made up into lines of a certain required length by a second person. Mr. Young calculates, that 14 or 15,000 letters may thus be set up in an hour, and that this, with the requisite attendance, will cost about 1½*d*. per thousand, or about a quarter of the present charge. For newspaper work, and other necessarily rapid printing, the machine appears well adapted. It is extremely simple, not liable to be out of order, occupies but little space, and as to wear may be considered imperishable.

POTABLE GOLD.

If there be no reason to think that gold will ever be made, is it not possible to employ this precious metal for prolonging life? Gold is a metal unalterable, and as difficult to be destroyed as to be made; it is the sovereign of the metallic world, as the sun, to which it is assimilated, is in the system of the universe. Nature therefore must have concealed in this valuable body the most useful remedies; but to make it useful, in this respect, it is necessary that it should be introduced into the body in a liquid form; it must in short be rendered potable: let us endeavour, then, to make potable gold. A life indefinitely prolonged is certainly worth all the treasures in the world. Such is in substance the reasoning of the alchemists, and therefore they have subjected gold to a multitude of operations, by means of which they have pretended to render it soluble, like a salt in water. The substance they produce has indeed the appearance of it; but to speak the truth, it is only gold very much attenuated, and by these means suspended in the liquid: in short, it is in no manner combined with the fluid, and it even gradually deposits itself at the bottom in the metallic form.

However, the following is a process for making a kind of potable gold. We shall examine afterwards, supposing it to be a real solution of gold, whether it would possess properties so marvellous, and so salutary to the human body, as is pretended.

First dissolve gold in aqua regia: mix this solution with fifteen or sixteen times the quantity of any essential oil, such as that of rosemary, stirring it round, and separate the aqua regia, which occupies the bottom, from the essential oil. If you then dissolve this essential oil in four or five times its weight of well rectified spirit of wine, you will have a yellowish liquor, known under the name of the potable gold of Mademoiselle Grimaldi.

Vitriolic ether, and ethereal liquids of different kinds, possess the same property as essential oils; namely, that of seizing on the gold dissolved in the aqua regia. A kind of potable gold therefore may be made with ether. This gold may then be taken in drops on sugar, in the same manner as when ether is taken; for this liquor is not miscible with water.

The celebrated drops of General Lamotte are not different from the potable gold of Mademoiselle Grimaldi. It has been remarked that one ounce of gold was diluted in 216 ounces of spirituous liquor, and as the bottles must have weighed two ounces, and as General Lamotte sold his for 24 shillings, it results that with one ounce of gold he made at least 108 bottles, from the sale of which he received at least 2592 shillings. In reality he made 136, which were worth to him 3264 shillings.

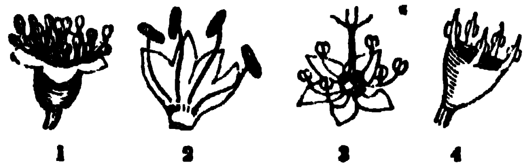
It hence appears, that if General Lamotte's drops were not useful to the health, they were exceedingly useful to his purse. But what will not quackery effect among mankind, when supported by ignorance and the love of life?

But let us examine whether there be any foundation for the wonderful properties ascribed to potable gold. A very little reasoning will show that nothing can rest on a slighter foundation. What proofs indeed can the alchemists produce, that potable gold is salutary to the human body? Because gold is the most fixed of all metals, because it has the beautiful color of the sun's rays, because it is represented in chemical characters by the characteristic sign of that luminary, are we thence to conclude that, when reduced to a liquid form, and conveyed into the blood, it regenerates that fluid, renovates youth, and restores health? What person, accustomed to deduce just consequences from any principle, will ever form such a conclusion? All the virtues of potable gold are founded merely on analogies, invented without any physical foundation, by fervid imaginations, and by heads deranged by the heat of their furnaces. This is the most favorable opinion that can be entertained; for it is probable that such ideas are as much connected with imposture, as with credulity and want of reasoning.

BOTANICAL NOTICES.

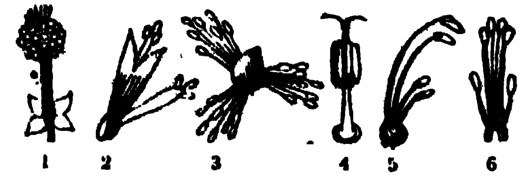
REPRODUCTIVE ORGANS OF PLANTS.

The stamens and pollen.—A flower may be perfect without having either calyx or corolla, but not unless it have one or more stamens and pointals, for these parts are necessary to the perfecting of the seed. The stamens are situated next within the corolla, and in a ring around the pointal, though sometimes connected with either one or the other, when their particular mode of growth or attachment occasion particular terms to be applied; thus when growing to the calyx or corolla they are called *perigynous*, (1, 2,)—when under the pistil, *hypogynous*, (3,)—or into the pistil, *epigynous*, (4.)



A stamen consists of three parts: the filament or thread-like portion, the anther on the top of this, and the pollen, which is a fine powder contained in the anther. Of these parts the two last are never absent—the filament sometimes is. The anthers vary considerably in size, form, color, and manner of attachment to their filaments, and also in their manner of opening, and scattering the pollen. In general this is accomplished by the anther, consisting of two cells, which open from one end to the other, suffering the pollen to fall out. In other cases, though these are not numerous, there are pores or holes upon a certain part of the anther through which it escapes.

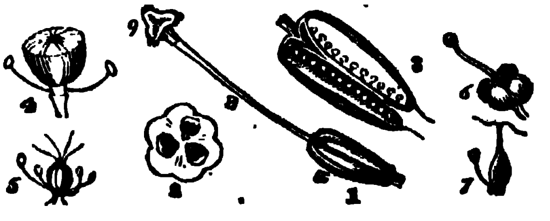
Stamens exist in plants not merely under different forms, but variously arranged; most frequently all within the same flower, and nearly of the same length; yet in whole classes a difference in them in this respect is perceivable, forming most essential distinctions; so also whether they may be free, that is, detached from each other, or in any manner united, is no less necessary to be remarked, particularly in the arrangement of plants, according to a system of classification. When stamens are united into one bundle by their filaments, they, and also such plants as have them thus, are said to be *monodelphous*, (1)—if united into two bundles, *diadelphous*, (2)—if in more than two, *polyadelphous*, (3)—if united by their anthers, they are called *syngenesious*, (4)—if of unequal length, they may be either *didynamous*, (5,) or *tetradynamous*, (6,) as is seen in the preceding illustration.



The *pollen* of plants is a most curious and beautiful object for the microscope. We are accustomed to see it as a yellow powder frequently, but it by no means always takes this color, various shades of orange, and through them to the bright browns, are common; shades of purple, blue, scarlet, and flesh color, are also frequent. In the garden tulip it is quite black—very seldom, if ever, green or white. Pollen is mostly spherical or oval, sometimes with a smooth, at others with a roughened or mamillated surface. Other shapes occur and some of them extremely curious.*

The pistil.—The pistil is the part in the centre of the flower, always connected with the stalk which bears the whole flower, and remaining attached to it long after the rest is faded or fallen. A perfect pistil consists of three parts:—First, the *germ* or *ovary*, which is the lower part, and constitutes the future seed vessel. Upon this is seated a thread-like portion, called the *style*. The summit of the style is swelled out, and rough or sticky: this is the *stigma*. The ovary and stigma are never absent—the style sometimes is, in which case the top of the ovary itself is called the stigma, as in *the poppy*, where it appears like the spokes of a wheel.

More pistils than one are very frequently met with. In many cases so united, that the ovary appears but a single body, and showing its compound character only by various divisions or *dissepiments* as they are called, seen across it internally. In other examples every ovary is distinct from the rest. The styles too are united throughout their whole length, partially so, or else entirely free from each other.



1. A perfect pistil. A. The ovary. B. The style. C. The stigma. 2. The ovary cut across, showing it to be three-celled, and to have the seeds attached to a central column. 3. The ovary cut lengthways, showing the attachment of the numerous ovules. 4. A pistil, with ovary and stigma, but without a style. 5. Four pistils, with their ovaries united, and styles distinct. 6. Ditto, with their ovaries distinct, and styles united. 7. Ditto, with their styles partly united.

The agency of these various parts in conducing to the perfection of the seed may be thus briefly described. The young seeds are contained in the base of the pistil long before the flower opens, and continue to grow until that time, but no longer, unless they are acted upon by the pollen of the anthers. Then they, in some manner wholly unaccountable to us, become fertile, increasing in size and perfect structure until ripe—when the seeds being scattered, they grow and produce other plants like that from which they sprung.

The reason of such an influence of the pollen is unknown, but the manner by which it reaches the ovary is easily explained. When the anthers burst, the pollen falls upon the stigma, some of it penetrates this, and arrives at and passes along the style;

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* An account of the pollen of plants as a microscopic object, has been fully described in Vol. I. page 276, where numerous figures are given.

and at length reaches the germ or base of the pistil, where the young seeds are contained.

The necessity of this process shows how it is that stamens and pistils are so constantly found in flowers, and also why the stamens surround the pistils so nicely as in general they do; and in circumstances where this is not the case, still some admirable contrivance is found for the same end.—Even insects, in their search for the honey of flowers, aid greatly in scattering the pollen from the anthers upon the stigma, and the conveyance of it from flower to flower—while the superfluous pollen which they collect upon their bodies is supposed to contribute to the formation of the wax or honeycomb. This they carry home to the hive, and there, like good subjects, contribute to the general welfare of the community in which they dwell.

The receptacle is that part of the pedunele upon which all the various inner parts of the flower are placed. In most plants it presents no appearance worthy of notice—in others, however, it is somewhat curious: for example, the fruit of the raspberry and blackberry easily come off, and show within them a thick, fleshy receptacle. In the strawberry, the whole fruit, (except the seeds upon it,) is a receptacle. In the geranium tribe, it grows into a long point, bearing the seeds from its summit. In the grasses, the part of the stalk which bears the florets is also called a receptacle; but it is in the class of compound flowers that the receptacle is most varied and most important. In the daisy it is conical: in the dandelion round. The thistle has it hairy, and the chamomile scaly: besides very numerous other distinctions. In truth, flowers of this class, (the nineteenth, syngenesia,) are, for the most part, distinguished from each other by the shape of the receptacle.

(To be continued.)

ETCHING DAGUERREOTYPE PLATES.

At a meeting of the Electrical Society, in the Adelaide Gallery, last week, a communication was received from Mr. W. B. Grove, on a voltaic process for etching Daguerreotype plates, and printing from them; not, it is true, as yet with the clearness and breadth of an ordinary etching, but with all the accuracy and delicacy of the original Daguerreotype, and with every promise of perfection. He says, the process possesses the advantage of simplicity, and produces a perfect etching of the original image; so much so, indeed, that a plate thus etched can scarcely be distinguished from an actual Daguerreotype, preserving all the microscopic delicacy of the finest parts of the impression. The secret of this process is to make the Daguerreotype the anode of a voltaic combination, which will not of itself attack either silver or mercury, but of which, when electrolised, the anion will attack these metals unequally. Admitting the usual explanation of the Daguerreotype, which supposes the light parts to be mercury and the dark silver, the object was to procure a solution which would attack one of these and leave the other untouched; if one could be found to attack the silver, and not the mercury, so much the better, as this would give a positive engraving, or one with the lights and shadows as in nature; but, unfortunately, silver and mercury are nearly allied in their electrical relations. Mr. Grove made several experiments with pure silver and mercury, used as the anode of a voltaic combination, but found that any solution which would act on one acted also on the other. All then that could be expected was a difference of action. With the Daguerreotype plates he has used the following:—Dilute sulphuric acid, dilute hydrochloric acid, solution of sulphate of copper, of potash, and of acetate of lead. But, after many experiments, hydrochloric acid was fixed upon as decidedly the best; this had been expected from the strong affinity of chlorine for silver. The manipulation employed by Mr. Grove and Mr. Gassiot, in the laboratory of the London Institution, was as follows:—A wooden frame is prepared, having two grooves at 0·2 of an inch distance, into which can be slid the plate to be etched, and another plate of the same size of platina; this latter is platinised after Mr. Smee's method, to ensure a ready and equable evolution of hydrogen; for if the hydrogen adhere to any parts of the cathode, the opposite portions of the anode are proportionably less acted on. The back and edges of the Daguerreotype are varnished with a solution of shell-lac, which is scraped off one edge to admit of metallic connexion being established. The wooden frame, with its two plates, is now fitted into a vessel of glass or porcelain, filled with a solution of two measures of hydrochloric acid + 1 distilled water, (sp. gr. 1·1;) and two stout platina wires proceeding from a single pair of the nitric acid battery, are made to touch the edges of the plates, while the assistant counts the time — this should not exceed 30 seconds. When the plate is removed from the acid, it should be well rinsed with distilled water; and will now, (if the metal be homogenous,) present a beautiful Sienna-colored drawing of the original design, produced by a film of the oxychloride formed. It should now be placed in an open dish, containing a very weak solution of ammonia, and the surface gently rubbed with very soft cotton, until all the deposit is dissolved. As soon as this is effected, the plate should be instantly removed, plunged into distilled water, and carefully dried.

The process is now complete, and a perfect etching of the original design will be observed. This, when printed from, gives a positive picture, or one which has its lights and shadows as in nature, and which is, in this respect, more correct than the original Daguerreotype, as the sides are not inverted. Printing can therefore be directly read; and in portraits thus taken, the right and left sides of the face are in their proper position. With respect to prints from Daguerreotypes, there is, however, this difficulty; if the plate be etched sufficiently deeply for a good impression, some of the finer shades of the original must inevitably run into each other, and thus the chief beauty of these exquisite images be destroyed; if, on the other hand, the process be only continued long enough to leave an exact etching of the original design, which can be done to the minutest perfection, the very cleaning of the plate by the printer destroys its beauty. At present, Mr. Grove considers the most important part of the process to be the means it offers of multiplying indefinitely Daguerreotypes, which, when thus etched at the voltaic anode, will admit of any number of copies being taken from them by the electrotype process; and, to give an idea of the perfect accuracy of these, there was one on which was a sign-board measuring on the electrotype copper-plate 0.1 by 0.06 of an inch. Five lines of inscription can, with the microscope, be distinctly read.

ON THE REFINING OF SULPHUR FROM EARTHY MIXTURES.

When sulphur is found in combination with earthy matter, its purification generally consists of two distillations; the first roughly performed on the spot where it is obtained, with the object of rendering the cost of carriage less expensive; the second is made with more care, near the spot where it is brought to market. At Solfatara the first distillation is executed in a furnace, or gallery, in which are arranged ten or twelve earthen pots, about twenty inches apart, in two ranges—each of these pots containing about thirty pints. When filled with ore, broken to the size of road metal, the top is luted down, but there is a tube connected with an opening in one of the shoulders of the jar, about two inches in diameter and fourteen inches long, which communicates with a second jar, pierced with a hole at the bottom, from which the sulphur flows into a tub of water, and is then condensed—it is sublimed in the first jar and cooled down in the second. At Marseilles there is a large establishment for the refining of sulphur, conducted by M. Michel, who invented the apparatus; it consists of a cast-iron retort, and a vast chamber, which serves as a conductor. The retort, containing about 1,500 or 1,600 lbs. of material, is heated by a furnace, which, however, has no communication with the chamber or the retort; an iron door in front serves to clear and re-charge the retort, the beak of which conducts the fumes of the sulphur to the large chamber, where they are condensed and collected either in a liquid state, or as the flowers of sulphur; the temperature of the condenser alone effecting the condition in which it is obtained. Much care is necessary to be observed in this process, as the admixture of a very small portion of air with the fumes in the chamber gives rise to explosions, which are sometimes dangerous, for it often happens that the temperature of the chamber is carried to the height of 150°, (sufficiently high to inflame the sulphur;) sulphuric acid is then rapidly formed, and in this process much heat is given out, and an explosion always follows. By valves placed at proper places this may be avoided, and the chamber should be freed of its oxygen by burning sulphur, or charcoal, in it before commencing to operate. Of late years the method which has been adopted, termed "decantation," has greatly removed the difficulty of the process, as explosions are now seldom know to occur. This arrangement consists in placing a large vessel, filled with crude sulphur, above the retort of distillation, and allowing the heat of the chimney to act upon it. A tube is made to wind round this vessel, furnished with valves, to permit the melted sulphur to flow through it, and communicate with the bottom of the retort containing the sulphur to be distilled; this disposition has the advantage of maintaining a more uniform temperature, and rendering the operation more rapid. By the ordinary method the loss amounted to about 18 or 20 per cent., but by M. Michel's modification the loss is reduced to 11 or 12 per cent. Notwithstanding these precautions, the fumes of sulphuric acid, which escape when opening the chamber to extract the sulphur, or clear it out, frequently destroys all vegetation in the neighbourhood; it is, therefore, important to construct them so that the sulphur can be withdrawn without entering the chamber. Eight or nine charges are usually evaporated before running off the sulphur. It is of great importance to have thermometers inserted in the chamber, at such places as they can be observed, as we have seen that, if the sulphur is above the temperature of 110°, and suddenly cooled, it loses its citron color, and is not so valuable in the market, although equally pure.—*Mining Journal.*

IMPREGNATION OF WATER WITH OXYGEN.

(Resumed from page 183, and concluded.)

“ 7. The fluid which now contains only hydrochloric acid, water, and oxygen, is placed in the glass it was first prepared in, and its temperature lowered by ice, as before. Then, stirring it continually, sulphate of silver, prepared by dissolving oxyde of silver in sulphuric acid, is to be added, by small quantities at a time; and it is essential that the sulphate contains no free oxyde. The sulphate is decomposed by the hydro-chloric acid, and there results water, chloride of silver which precipitates, and sulphuric acid in place of the hydro-chloric. When the quantity of sulphate of silver added is sufficient to decompose, perfectly, all the hydrochloric acid, the fluid suddenly becomes clear; until that is the case it remains turbid. As it is required that no hydro-chloric acid should remain, so also no excess of sulphate of silver should be present; and therefore the fluid must be tested successively by nitrate of silver and muriatic acid, very small quantities of the fluid being used for this purpose.

“ When the proportions are well adjusted, the fluid is to be passed through a filter, and the filter, after being allowed to drain, is to be compressed in a cloth. The fluid obtained by the compression, must be again passed through a filter, in consequence of a slight degree of turbidness.

“ 8. The object of the preceding operations has been to obtain a fluid composed of water, oxygen, and sulphuric acid. But this acid must be separated; for this purpose the fluid is put into a glass mortar, surrounded by ice, and slaked barytes, very pure and finely powdered, is to be added by small portions at a time; it is to be rubbed again in the glass mortar, and when it is all united to the acid, a fresh portion is to be added. When the fluid scarcely reddens litmus paper, it is to be filtered, and the filter compressed in a cloth; then, after having united the two fluids, they are to be stirred, and the saturation of the acid completed by barytes water. There must even be a slight excess of barytes water added, to separate all traces of iron; and, above all, of manganese, which the fluid may still contain; and it is of importance to remember, that it must be filtered immediately after, with all the precautions before given. The excess of barytes may then be precipitated by a few drops of weak sulphuric acid, and it is better to leave a slight excess of the acid present, rather than of the base, because the last tends to disengage oxygen, whilst the first renders the combination more permanent.

“ 9. Finally, the fluid, which may be considered as pure oxygenated water, diluted with common water, is to be put into a clean glass having a foot, and this glass placed in a large capsule, two-thirds full of concentrated sulphuric acid. This apparatus is to be placed in the receiver of an air-pump, and a vacuum made. Pure water having a greater tension when in vapor than oxygenated water, evaporates more rapidly, so that at the end of two days, the fluid will contain perhaps two hundred and fifty times its volumn of oxygen. The following observations must be attended to :—

"The acid must be agitated from time to time.

"It happens sometimes that towards the end of the evaporation, the fluid disengages a little gas, which is indicated by the variation of the mercury in the gauge. This disengagement is occasioned, no doubt, by extraneous substances which remain in the fluid; it may be stopped by the addition of two or three drops of extremely dilute sulphuric acid.

"Sometimes the fluid will deposit some white flocculi of silex. These should be separated. The fluid may be decanted by a pipe with a very fine termination, and but a small quantity of it will be lost.

"Until the fluid becomes very concentrated, the evaporation goes on very quietly, but when the oxygenated water scarcely contains any more water, bubbles frequently rise, which burst with difficulty. At first sight, it seems as if much oxygen gas escaped, but on examining the gauge, it will appear very trifling. It will scarcely become sensible in twenty-four hours, and the alteration then observed, is in part occasioned by the disengagement of gas from the sulphuric acid, belonging to a portion of the oxygenated water which has been evaporated.

"The fluid may be known to be in the most concentrated state possible, when it gives four hundred and seventy-five times its volumn of oxygen at the pressure of 30 inches, and temperature of 57·2 Fahr. This proof is readily made by taking a small tube, on which a line is marked, and filling it with the fluid up to the line, and then diluting this quantity, which, in my experiments was always $\frac{3}{100}$ of a centilitre, (0,030514 of c : i :) with twelve times its volumn of water, and decomposing a certain quantity of this last fluid by oxyde of manganese. This last experiment consists in filling a tube 15 or 16 inches long, and 7 or 8 lines wide, with mercury, to within an inch of the top; then introducing the portion of diluted fluid, of which the analysis is to be made, using for this purpose a small tube of known capacity, afterwards filling the tube with the water used to wash the small measure, or partly with mercury, and then, by closing the tube with a valve covered with tallow, inverting it, and passing in a little oxyde of manganese diffused in water. The oxygen will be immediately disengaged, and nothing further is required than to close the tube with the hand, and shake in different directions, that the contact of the oxyde of manganese and the water may be ensured, and to measure the gas."

INDIGO.

Indigo is obtained chiefly from different species of *Indigofera*, an American and Asiatic plant, cultivated as a source of this article; it is also obtained from the *Nerium tinctorium*; and from some species of *Isatis*, or *woad*. The dye is extracted either from the fresh or dried plant, by suffering it to ferment with water, during which it undergoes chemical changes, which ultimately cause its deposition in the form of a blue feculent deposit, which is collected and dried. The general characters of indigo, as it is found in commerce, are the following :—it occurs in square cakes, or cubical masses of a deep blue color, and generally containing about 50 per cent. of pure coloring-matter, which is perfectly insoluble in water; when heated to between 500° and 600°, it affords a sublimate in the form of a blue smoke, which, on condensation, forms acicular crystals, amounting in weight to 18 or 20 per cent. of the original indigo. It is soluble in concentrated sulphuric acid. This solution is usually called Saxon, or liquid blue, and is used as a substantive color for dyeing cloth and silk. Substances which powerfully attract oxygen render indigo green, and by exposure to air, it again acquires a blue color. In this green state, indigo is soluble in the alkalis, and the solution is commonly employed for dyeing calico. A bath for this purpose may be made by mixing 1 part of indigo, 2 parts of sulphate of iron, and 2 of lime, in a sufficient quantity of water: in this case, the sulphate of iron is decomposed by a portion of the lime. The protoxide of iron thus produced becomes peroxidized at the expense of the indigo, which is rendered green and soluble in the alkaline liquor; cotton steeped in this solution acquires a green color, which, by exposure to air, and washing in water acidulated with sulphuric acid, becomes a permanent blue. A little iron or zinc thrown into diluted sulphate of indigo changes or destroys the color in consequence of the evolution of hydrogen; the color is also quickly impaired and destroyed by chlorine.

Indigo has been subjected to an interesting series of experiments by Berzelius, who found its usual constituents to be four distinct substances: viz., 1, gluten; 2, a peculiar brown substance, apparently resembling extract; 3, a red substance, which gives a white sublimate when heated in close vessels; 4, indigo blue. 1. The substance which Berzelius terms gluten, is soluble both in alcohol and water, and was obtained by digesting powdered indigo in dilute sulphuric acid, neutralizing the solution by chalk, filtering, evaporating to dryness, and digesting the residue in alcohol. 2. The brown matter was taken up from the indigo (freed as above from gluten) by potassa, and neutralizing the solution by sulphuric acid; this occasions a precipitate containing a peculiar brown matter. 3. Upon the indigo, purified by dilute acid and by the action of solution of potassa, strong alcohol was digested, which takes up a red substance, insoluble in water and alkalis, soluble in concentrated sulphuric acid, and in nitric acid, and which, when heated in vacuo, yields a grey crystalline sublimate. 4. The substance remaining after the action of the above solvents is the real coloring matter of the indigo, or indigo-blue, and is that which forms the purple vapor and sublimate above alluded to. It forms a deep-blue solution of great intensity with sulphuric acid, and especially with the fuming and partly anhydrous acid (Nordhausen acid), and is, in fact, the principal ingredient in the sulphuric dyeing-liquor already mentioned.

The action of sulphuric acid upon indigo has been investigated by Mr. Crum. The concentrated acid does not merely dissolve it, but, in the course of twenty-four hours, alters its properties; it at first becomes yellow, in consequence, probably, of the abstraction of the elements of water, for much heat is evolved, and the addition of water instantly restores the blue tint. Nothing is given off or absorbed, nor is carbon precipitated. When the sulphuric solution is neutralized by potassa, an intensely-blue precipitate falls, soluble in water, but insoluble in saturated solutions of the salts of potassa; it was, therefore, purified by alternate washing with solution of acetate of potassa and alcohol.

When dry it acquires a copper-color, is very hygrometric, soluble in 140° degrees of cold, and in a smaller proportion of hot water. The cold solution, even when largely diluted, furnishes insoluble precipitates with salts of potassa, soda, lime, baryta, strontia, lead, and mercury. This substance has been called *Cerulin*, and exists in the precipitate as a ceruleo-sulphate of potassa: it appears to be a hydrate of indigo, in which 1 proportional of indigo is combined with 4 of water.

By limiting the action of the acid upon the indigo to three or four hours (or at 100° to 20 minutes), different results are obtained. 1 part of purified indigo was shaken in a phial with 10 of sulphuric acid till it became green, it was then poured into water, and filtered. The first washings of the substance upon the filter are to be rejected; but when the liquid passes of a blue color, solution of chloride of potassium may be added, which throws down a purple precipitate, called by Mr. Crum, *Phenicin*. This substance is soluble in water and alcohol; it is converted by sulphuric acid into cerulin; it is precipitated by almost all saline substances of a purple color; it appears to contain 1 proportional of indigo and 2 of water.

MEMORANDA.

Regnault, in his researches on the specific heats of compound bodies, either liquid or solid, arrives at the following conclusions:—1. In metallic oxides of the same chemical formulæ, their specific heats are in inverse proportion to their atomic weights. 2. In the sulphates composed of one atom of sulphur, their specific heats are in inverse proportion to their atomic weights. 3. In compound bodies, having the same electro-negative elements, and a like atomic constitution, the specific heats are in inverse proportion to their atomic weights. 4. In all compound bodies of the same atomic composition and chemical constitution, their specific heats are in inverse proportion to their atomic weights.—*Comptes Rendus*.

Length of Days.—At Berlin and London, the longest day has 16 hours and a ½. At Stockholm and Upsal, the longest has 18 hours and a ½, and the shortest 5 and a ½. At Hamburgh, Dantzic, and Stettin, the longest day has 17 hours, and the shortest 7. At St. Petersburgh and Tobolsk, the longest has 19, and the shortest 5 hours. At Torneo, in Finland, the longest day has 21 hours and a ½, and the shortest 2 and a ½. At Wardorbus, in Norway, the day lasts from the 21st of May to the 22nd of July, without interruption; and in Spitzbergen the longest lasts 3 months and a ½.

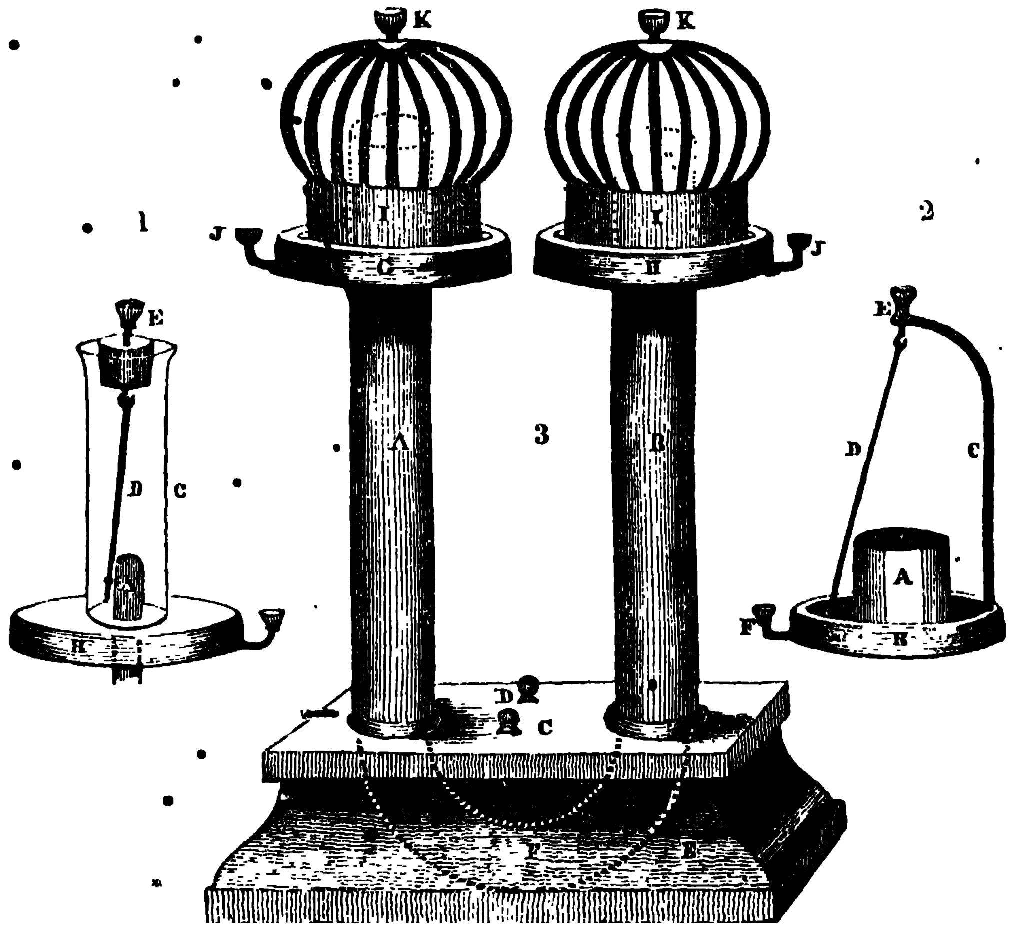
New Plan of Launching Ships.—The Liffey, West-India mail packet, has been launched from Mr. Wimshurst's patent steam-ship building yard, Millwall, Poplar. The Liffey is considered a very sharp vessel, and was launched on Mr. Wimshurst's plan. In lieu of cleats, &c., nailed or screwed to the bottom, a rod of iron is bent round the top of the poppets or slopings up on both sides, passed under the keel, and shackled together; a chock of hard wood is fitted between the keel and sod, with a wedge driven between the keel and chock to tighten the poppets to the vessel's bottom; then set the vessel up in the usual way with drivers. A chain being attached to the irons draws all out clear when the vessel goes into the water. Vessels of the largest size may be coppered and fitted ready for sea when launched on this improved plan, without going into dock.

New Indelible Ink.—M. Beranger has sent to the French Academy of Sciences, a description of a new economical ink, for which he has taken out a patent. It consists of lamp black mixed with gelatine and caustic soda. By adding an aromatic gum to this ink, it is difficult to distinguish it from Chinese ink, its qualities being the same alkaline and indelible, but its cost much less.—*Moniteur Industriel.*

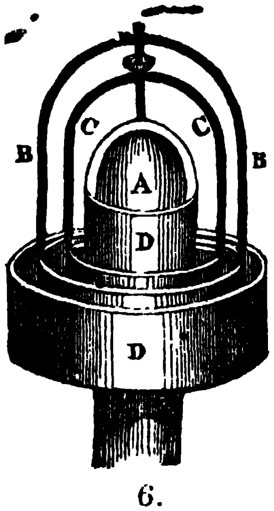
Advantage of Planting Fruit Trees on Declivities.—Dodart first observed that trees pushed their branches in a direction parallel to the surface of the earth. If a tree stands on a steep it pushes both towards the hill, and towards the declivity; but on both sides it still preserves its branches parallel to the surface. As there is an attraction between the upper surface of leaves and light, I am also persuaded, though not equally certain of it from experiment, that there is an attraction of the same nature between the under surface of leaves and the surface of the earth. This I consider the true cause of the phenomenon. I had long observed that the most fruitful orchards and most fertile trees are those planted on a declivity, and the steeper it is, though not quite a precipice, the more fertile they prove. It is well known that the spreading of trees always renders them fruitful. On a plain they incline to shoot upwards; and therefore art is employed by skilful gardeners, and applied in various ways, to check their perpendicular, and to promote their lateral growth. But this point is obtained on a declivity by nature. There a tree loses its tendency to shoot upwards, and in order to preserve its branches parallel with the surface, is constrained to put them in a lateral direction. Hence an important rule in the choice of orchards and fruit gardens.—*Rev. D. J. Walker.*

Galvano-plastic Wonders.—A letter from Munich informs us, that the celebrated Bavarian sculptor, Stigelmayer, has brought to such a pitch of perfection his galvano-plastic process, that its effects would be deemed fabulous were they not publicly exhibited in the Museum of the Society of Arts. In the space of two or three hours colossal statues in plaster are covered with a coat of copper, which takes with the greatest accuracy the most minute and delicate touches, giving the whole all the appearance and solidity of the finest casts in bronze. M. Stigelmayer has also applied his process to the smallest objects, as flowers, plants, and even insects, bringing them out with such accuracy, that they seem to have been executed by the hands of the most skilful artists.—*Literary Gazette.*

Hemp from Bean Stalks.—Every bean stalk has 20 or 30 fibres, running up on the outer side under a thin membrane from the bottom to the top of the plant. There is a particular fibre at each of the four corners of the plant, rather thicker and stronger than the rest: it is sometimes made use of by anglers, instead of sea grass, for fixing their hooks. These fibres are easily separated after the plant has been soaked 10 or 12 days in water. Washing and pulling it through hackles or iron combs is necessary in dressing bean hemp. It is not requisite that the stalks should be kept exactly 12 days under water; they may remain any length of time, so that they are either quite under water, or perfectly dry.



ELECTRO-MAGNETISM.



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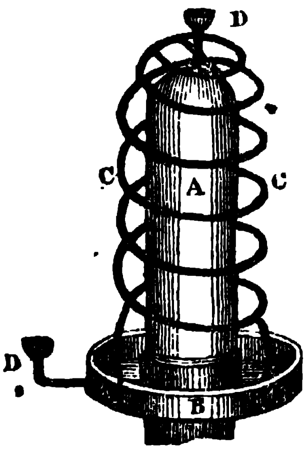
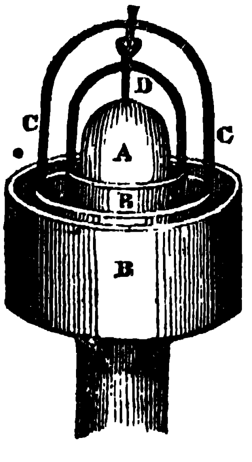




ELECTRO-MAGNETISM.

(Resumed from page 122.)

WE have, perhaps, sufficiently explained the action which magnets and wires, conveying a current of electricity along them, mutually exert upon each other, in producing vibratory and rotatory movements. There are, however, numerous experiments equally conclusive, and performed with more convenient apparatus than some we have had occasion to introduce; we therefore revert to what is passed, and then pursue the subject further. It was shown in page 378, vol. ii., that a wire which conveys the electric fluid along it, provided it were free to move, would revolve around the pole of a magnet placed under it, as was proved by Dr. Faraday, a section of whose apparatus may be seen in fig. 1, where A shows the pole of a magnet—B a foot-stand, with a mercury cup, communicating by a wire with the interior of the glass tube C. This tube contains a little mercury sufficient to cover the end of the wire I, which leads from the hook of a second wire at the top, such wire passing through a cork, and terminating in a mercury cup E at top.

In this apparatus it is evident that when the cup E is connected with the positive pole of a galvanic battery, the other pole being also connected with the lower cup, the fluid will have no channel but along the wire I, and the consequence will be that it will revolve around the magnet pole.*

A much more convenient form of the apparatus is seen in fig. 2, where A is a cover or case of paper that fits upon the pole of a large magnet. B is a circular wooden trough for mercury, having a cup F. C is a wire to support the mercury cup E. and the suspended wire D. If one wire thus revolves, so would two, and so would any number of wires, and this whether the wires were distinct from each other or united together; and as a cylinder may be considered but as an aggregation of wires, a metallic cylinder, placed in the same circumstances, would in like manner revolve. This fact, which was fully established by Mr. Barlow, suggested to Mr. Sturgeon an exceedingly elegant apparatus, called Sturgeon's crown. Two of them are shown, as placed upon the poles of a horse-shoe magnet A B, (fig. 3.) From the mercury cups at top K K proceed straight wires, pointed at their lower end, and resting in an agate cup on the top of the magnet. To the wires are soldered a piece of thin brass, cut like the spokes of a wheel, from a round piece in the centre. The spokes being bent down are soldered to a rim, as represented. The lower end dips into mercury, with which the cups J J are united.

It may be asked why there are two crowns shown? It is because the direction in which the wires turn depends upon various circumstances, particularly as to the direction in which the current of electricity is made to pass, and the pole of the magnet round which it revolves, whether north or south. The course of rotation of the wire, and consequently of all other apparatus of the same kind, will be from left to right, or the same with that of the hands of a watch, when the electric current is descending along the wire, and the upper end of the magnet is the south pole. The motion is reversed when either of these conditions is reversed. This may be conveniently exhibited in the two poles of the same magnet by employing a horse-shoe magnet, as represented in fig. 3, where A B F is the magnet. E the stand of it. D C two screws holding the magnet in its proper place, by a cover to the lower part of the stand. As the magnetic power penetrates through all obstacles except iron, the legs of the magnet A B may be covered with brass cases without impairing their effect. From what has been said, it is evident that if two crowns are suspended one over each pole of the magnet, the current descending or ascending in both, they will rotate in contrary directions.

If a spiral wire be substituted for a straight one, it will in like manner rotate; a wire of this form is seen in fig. 4, where D D are the mercury cups. C C the wire, and A B one pole of the magnet.

There is another point of view in which we have not yet considered the subject. It is that in which the magnet not merely affects a conducting wire, but the electro-magnetic battery itself. It is found that the stream of electricity, which is passing through the voltaic battery itself, from its negative to its positive pole, exhibits the same electro-magnetic properties that it does while passing along the wire, which completes the circuit by connecting the two poles; for a magnetic needle placed in the vicinity of the battery, and in circumstances equally favorable to the action of the current, will be affected in the same way as it is by the wire itself. Now as all action implies a corresponding and equal re-action, it is reasonable to infer that as the battery produces motion in the magnet, so the magnet might be made to move the battery, if a sufficiently delicate suspension could be contrived for the latter so as to render its motion sensible. This object has been accomplished by Ampère. The apparatus he used consisted of a double cylinder of copper B B, (fig. 5,) closed at the bottom and supported by a wire across the top of the inner cylinder, upon the pole of a magnet. Upon a mercury cup, connected with this wire, is suspended a second wire C C, bearing at the bottom of it a ring of zinc. When a dilute acid is poured into the space between the two copper cylinders so as to immerse the ring of zinc, the whole forms a galvanic circuit, the moveable part of which will rapidly rotate; if the copper be fixed, the zinc alone will move; but if the copper be made larger than the top of the magnet, and freely suspended upon a second point, as was suggested by Mr. Marsh, and as we have represented, the copper vessel and contents will rotate in one direction, while the zinc and its wire will take the contrary. The apparatus may be still further varied by supposing the copper vessel to be fixed on the magnet, and not forming a part of the battery. The galvanic action arising from a rim of zinc, as before, and a similar but rather larger rim of copper and arm of wire, as represented in fig. 6, where D D is the fixed copper cup. B B the wire of the copper rim. C C the wire of the zinc rim; and A the magnet. In this apparatus the zinc and copper rims turn different ways, and with greater rapidity than in the former instance, the liquid not having to be carried along with it. We must defer till another opportunity the concluding part of the subject, viz. the effect of electro-magnets upon each other; and this will explain to us more particularly the action of electro-magnetic machinery, and how it is that electro-magnets, though their attraction, repulsion, and other properties, depend upon the same laws as ordinary magnets, will yet accomplish what magnetism alone is unable to effect.

(To be continued.)

CURRENTS OF THE OCEAN, AS CONNECTED WITH GEOLOGY, &c.

Navigation seems intimately connected with geology as a science. Because the outlines of our earth, as divided into land and water, having been determined primarily by physical forces, or the action of oceanic currents, and the flux of tides therefrom, as they still either set or run—ascending from an uplifted order out of rocks, to deposits of indurated mud, cemented sand-stone, a concrete of limestone, and aggregates composed of debris from all that had gone before, so have these currents of the ocean, or the tides flowing from them, either scoured out deep water, covered various shores and seas with shallows composed of sand, silt, or shingle, or have formed by such physical agency those natural havens into which sea vessels may be safely navigated, anchored, or securely moored. A little attention to physical laws must abundantly satisfy any body, capable of assorting and classifying ordinary thoughts, that physics in organic forms not only constitutes a leading instrument by which intelligence, either divine or human, works out its ends, but as placed in the hands of Almighty foreknowledge, in some measure explains the sequence and mysteries that belong to the order in time in which the earth has been constructed. The sun would appear to be the main driving power, through the medium of highly-elastic agency, that works a system of which it is the common centre; and without asking what lies beyond the sphere of these organic forces, we may, in the first place, consider the earth as a member of the solar system, next as involving the moon in its orbit, and finally as the originator of forces that wholly belong to itself, and have been intimately concerned in working out the providential frame of its own construction. Let the sun as a driving power, therefore, be taken at some determinate rate, then the earth in a primarily nebular form, as a body neither much compressed nor condensed by organic forces, on the law that a ball composed of pine, with any given diameter, and driven by some given power, would move in a corresponding orbit and revolve on its axis at a higher rate of speed than a ball having a like diameter, and placed under consimilar terms would do, if composed of heart of oak. So would the earth move slower in its orbit, and revolve slower on its axis, accordingly as its volumn or diameter were com[illegible]d by the centricity of gravitation, and progressively condensed to the solidity and diameter it now maintains. The motion of the earth, therefore, in its orbit and on its axis, in conformity to a plain rule in physics and organic forces, may be truly inferred to go now at a vastly reduced rate of speed, than in a nebular state; and when an excess of speed caused its form to take that of an oblate spheroid, and thereby balance itself on its axis, by its most elongated zone having a constant tendency to sink downwards (on the principle that vessels float,) and necessarily re-ascend again in alternate revolutions, until a compressed and condensed nucleus, by an excess of speed in a lineal direction, or by an excess of centrifugal force, threw out lines of rocks longitudinally across the equator, or from the equator in the direction of the poles of the earth.

When the granite formation and the rest of its order, therefore, had been so lifted from or pitched out of the bosom of the earth by centrifugal force, or an excess of motion in its orbit and on its axis, a depository process would immediately commence, a portion of the previously fluid materials of the earth would then take a fixed and more solid form, when a further compression and condensation of the earth's body would necessarily follow such an event; and again cause our planet to move slower in its orbit and on its axis than previously, in correspondence with the progressive advancement of a depository process.

Hence the same law of centrifugal force, still somewhat in excess, which threw out vast and stupendously elevated lines of granite within the tropics, and in the direction of the poles, would also scour out enormous cavities within the regions of the poles, lift the material in the direction of the tropics, and so forward the work of deposition, until a further compression and condensation of the body of the earth would retard its motion, the volumn of its fluids would diminish, they would be checked in their motion by accumulated deposits resting upon a previously uplifted formation; and progressively, as the terms on which this process depended had advanced in their extent and influence, would the currents of the ocean retreat more from the equator, sink gradually into the Polar Basin, and finally leave the figure of the dry land of the earth, in elevation and surface lineaments, that which we now find them to be—with the exception of volcanic products, reefs of coral, and such like trivial anomalies, here and there scattered upon the earth's surface.

Flux and re-flux of tides, obviously derived from those oceanic currents which yet run from the south pole to the equator, then descend upon the north pole, re-ascend to the equator, and again return to their starting place at the south pole (running at the same time in a western direction, in accordance with the eastern revolutions of the globe,) would also partake of and follow the diminished speed of the currents from which they originate, and lie subdued in polar deeps. Hence have the proud waves been stayed by omniscient means, and an Almighty hand. They have gone down into the cavities of the polar deep primarily scoured out for their reception, "that they turn not again to cover the earth."

At the same time, proportionally as centrifugal force were lessened in power, would the concentricity of the earth augment correspondingly, and multiply in pressure towards its centre. Hence those waters, that are still lifted from the poles to the equator by a centrifugal power, if the unstratified rocks lie in continuous chains of porosity, are imperceptibly going partly through the body of the earth to the poles again, by the force of a centripetal law, which plainly contributes so much to a concentric tendency. The five orders into which geology as a science plainly divides itself, are, therefore, distinctly framed in accordance with an obvious law in physics, which gave to the undermost rocks the most conspicuous altitudes, and to the uppermost rocks an invariable depression of surface. Hence geology classifies itself by a most ready rule. Ben Nevis is the highest mountain in Britain, and therefore decides an unstratified class; Snowdon is the next in succession which does not come within this class, and being composed of deposited and indurated mud, decides the second formation. The Black Mountains in South Wales form a third step downwards, which cannot be classed along with indurated mud—being composed of cemented old red sandstone. The Yorkshire

Moorlands give a fourth step downwards, and being composed of lias, in which an excess of lime obtains, they decide the great limestone order from lias to chalk. To these, as the most depressed in elevation, yet the uppermost in stratification, succeed a fifth order of deposits, composed of the off-scourings of all that had gone before—granite, indurated mud, cemented sand, and a concrete in which lime is the predominant ingredient. The scale of descent from the altitude of the undermost rocks to the level of the uppermost order of deposits above the sea is, therefore, as follows :—

		Feet above the sea.
1st order,	Ben Nevis, granite, &c., unstratified	4,358.
2nd ——	Snowdon, indurated mud	3,571.
3rd ——	Black Mountains, cemented sandstone	2,862.
4th ——	The Yorkshire Moorlands, lias or limestone	1,485.
5th ——	Diluvial Beds, debris from the above	700.

Showing most fully that the position of rocks, according to the ascending series of a depository process, exhibits the uppermost rocks as most depressed in altitude, and the undermost order as the most elevated. This rule, as applicable to the Cumberland and Westmoreland group of mountains, is exceedingly impressive. On emerging from a group of hills that mainly belong to the second order, where the cultivation of land is exceedingly limited, we suddenly come to a zone composed of the sandstone order and its usual accompaniments (which completely encircles the older order,) every inch of which either has been or is adapted to cultivation; and yet the diluvial class take a level in descent equally palpable and still better adapted to cultivation on the whole.

When geology as a science rests on these premises, subjected to the rigid evidence of facts and the most severe rules in physics, it follows that the undulations on the surface of our globe are mainly attributable to the scour of oceanic currents, and to tidal pulsations flowing therefrom, accordingly as the moon and the sun wade across the courses of these several currents that cross the equator from pole to pole; for tides are no more than undulations in the set of oceanic currents. What has been stated, therefore, shows that deep water is almost always liable to dangers in navigation, which are exceedingly delusive, and too often unknown to our best seamen, owing to currents, either oceanic or tidal, commonly setting in upon, or abutting against, those shores on which deep water obtains to their very edge.

In "Geology as a Science," page 39, it is stated that a "current holds its course across the Atlantic, and, on the eastern coast of America, abuts on Cape de Saint Roque, a point on which these waters, in some measure, shed themselves, running southward in the direction of Cape Horn, and northward along the north-east coast of South America." In speaking about the currents of this coast, Captain Fitzroy observes, in the voyages of the *Adventure* and *Beagle*, vol. ii., page 60, in steering for Bahia de Todos Santos, "From the 23rd to the 27th of February, 1832, we found a current setting us southward, between twenty and thirty miles in each day. This was quite unexpected by me, for I thought that we should have been set westward;" overlooking the fact that he had passed to the southward of the water-shed pointed out as above; and having, therefore, passed the boundaries of a westward current had got into a southward one. Owing, probably, to a similar mistake, and also an acquaintance with the fact on such a shore deep water may be taken as a proof that either a current or a tide wave, or perhaps both of them, set in shore, and occasioned the *Thetis* frigate to run right on shore, at Cape Frio, on the 4th of December, 1830. Nor is it unlikely that the *Challenger* shared a similar fate, owing to a corresponding mistake, to the southward of Conception, on the western coast of South America, in the night of the 19th of May, 1835, from not considering that deep water may lie in the very focus of the highest dangers, showing very distinctly how intimately the general theory of oceanic currents, and their local bearings also, are connected with navigation, in warning seamen against insidious dangers to which deep water is liable, as well as avoiding those shallows so common on the lines of cross currents.

BOTANICAL NOTICES.

(Resumed from page 189, and concluded.)

THE FRUIT OR SEED VESSEL

Fruits or *pericarps* are all those cases or vessels in which ripe seeds are naturally contained. If it open to suffer the seeds to escape from it, the pericarp is said to be *dehiscent*, and the various parts into which it divides are called *valves*—a seed vessel that does not open thus is called *indehiscent*.

Fruits may be divided into those in which the seed and seed vessel are united together; and those in which they are distinct, and easily to be separated. The first class are of necessity all dry and indehiscent fruits, and are usually called and considered *naked seeds*, as well as some of the others. The second class is divided into dry, fleshy, pulpy, and scaly fruits, as follows:—

DRY FRUITS.

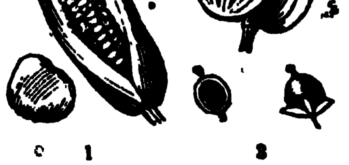
In which the pericarp is united to the seed.

1. *Caryopsis* or *grain.*—A single carpel or fruit, situated above the calyx, (called therefore *superior*,) as the seeds of wheat, barley, and the other grasses, Indian corn, &c. (Fig. 1.)

2. *Cremocarp.*—A double carpel, situated under the calyx, (called therefore *inferior*,) as is seen in the goose-grass; also in the celery, parsley, carraway, and all other plants, of the natural order umbellatæ. (Fig. 2.)

In which the seed is loose in the pericarp.

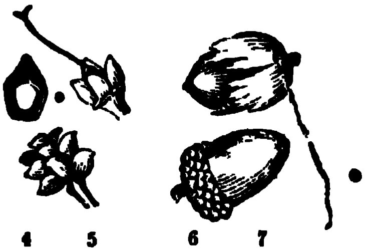
3. *Utricle.*—A one-celled small, thin, dry, one or few-seeded fruit, which does not open, (indehiscent,) as in the goose-foot, &c. (Fig. 3.)



4. *Nut.*—A single seed, inclosed in a stony covering only, as in lithospermum, and all the commonly called naked seeds of the rough-leaved plants of the fifth class, and those of the first order of the fourteenth. The small yellow specks on the outside of a strawberry are also nuts; and so are the numerous carpels of the ranunculus, though, in these two

instances, the whole fruit is called an *Etario*. (Figs. 4 & 5.)

5. *Gland.*—A one or two-seeded fruit, with a leathery or stony covering, wholly or partly inclosed in a leafy or fleshy coat, (when cup-shaped called a *cupule*,) from which the fruit falls out when ripe, as the walnut, chesnut, hazel and filbert, acorn of the oak, &c. (Figs. 6 & 7.)



Note.—Let it be observed, that although a whole fruit may have a certain character, and be called by a particular name, yet it may consist of parts which, were they alone, would entitle the fruit to another name: thus, as before observed of the strawberry, although the whole is a pulpy fruit, yet the specks upon it, and which contain the seeds, are truly *nuts*, so it is of the filbert, &c. Removed out of their envelops, the pericarp is a nut; so would be the stone of the cherry, plum, and others. An acorn without its cup is a capsule, as is also the core of an apple; and many other examples might be adduced to show that it is not merely the structure of the pericarp itself, but the circumstances of its growth, and the nature of its envelops, which must be observed in considering the fruit.

6. *Samara.*—A winged, leaf-like pericarp, of one or two cells, as the fruit of the ash, maple, elm, &c. The *samaras* of the sycamore are commonly called *keys*, from their hanging in bunches. (Fig. 1.)

7. *Capsule.* A thin case, containing many seeds either suffering the seeds to escape by pores, as in the poppy and the snap-dragon; or splitting into *valves* or pieces, as in the stramonium, the tulip, lily, &c. Sometimes it breaks across transversely, throwing off the upper half, as in the pimpernel. (Figs. 2 & 3.)

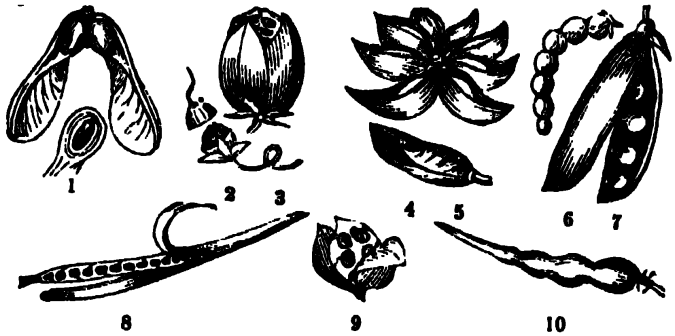
8. *Follicle.*—A capsule, which opens only on one side. There are mostly several follicles together, but capsules are generally solitary. The fruit of the pæony, monk's-hood, columbine, &c., are follicles. (Figs. 4 & 5.)

9. *Legume* or *pod.*—A long two-valved capsule, with one cell and many seeds. The seeds attached to one of the *sutures* or the line of union between the two valves, as the pod of the bean, pea, vetch, lupin, &c. Sometimes the pod breaks across into numerous pieces, as in the bird's-foot, the horse-shoe vetch, &c. This form is sometimes called a *lomentum.* (Figs. 6 & 7.)

10. *Silique.*—A long, two-celled, many-seeded pericarp—different from the legume in having two rows of seeds, one attached to each suture; and the two valves peeling off from the bottom upwards, leaving a thin paper-like membrane between them, as the fruit of the stock and wallflower. (Fig. 8.)

In a few plants, as, for example, the radish, the silique does not divide, but as is the case with that variety of the pod, called lomentum, it breaks up into joints. (Fig. 10)

11. *Silicle.* This fruit differs only from the last in being but little longer than it is broad, as in lunaria, draba, &c. (Fig. 9.)



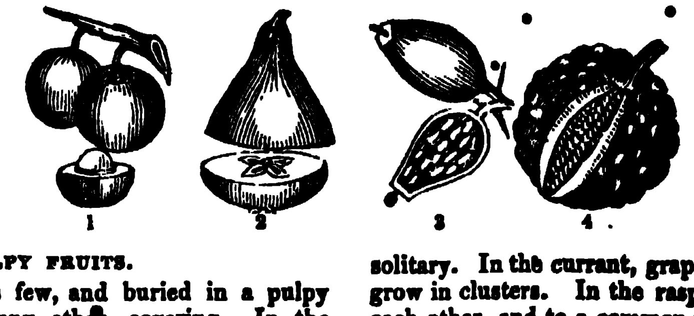
SHY FRUITS.

12. *Pome.*—A fruit, with its seeds placed in dry cells in the middle of a fleshy rind, as in the apple, pear, &c. (Fig. 2.)

13. *Drupe.*—Consists of a nut, inclosed in a fleshy mass, as in the plum, peach, apricot, &c. (Fig. 1.)

14. *Hip.* Several nuts, inclosed in a fleshy calyx, as in the rose. (Fig. 3.)

15. *Pepo.*—Seeds numerous, surrounded with pulp, and attached to the inner side of a fleshy shell, as the cucumber, gourd, melon, capsicum, &c. (Fig. 4.)



PULPY FRUITS.

16. *Berry.*—Seeds few, and buried in a pulpy substance, without any other covering. In the gooseberry, bilberry, cranberry, &c., the berries are solitary. In the currant, grape, barberry, &c., they grow in clusters. In the raspberry, &c., united to each other, and to a common receptacle. (Figs. 1, 2, 3, & 4.)[*]

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[*] The strawberry, too, was formerly, by Linnæus, called a berry; but it is clear that it resembles no other kind of berry, but should properly be joined to the cashew nut, under a distinct name, its character being one or more nuts, seated on the outside of a fleshy receptacle. Much difference of opinion exists among botanists as to the arrangement of fruits, particularly of the berries—but these nice distinctions are of comparatively little importance.

17. *Hesperidium.*—Seeds few, seated around the axis of a fruit, which has an easily-removed spongy skin, and a pulpy core, separable into sections, as the orange, lemon, &c. (Fig. 5.)

SCALY FRUITS.

18. *Strobilus* or *cone*, is composed of a number of woody scales, folding over each other—under all of which is nut-like seed, as in the fir apple. (Figs. 1, 2, & 3.)

Nearly the whole of the fir tribe bear this kind of fruit. They are therefore called coniferæ or cone bearing.

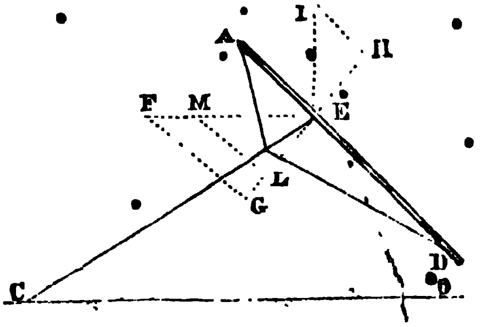
The obvious purpose of seed vessels is to contain and defend the seeds during the progress of their growth. They are, besides this, greatly conducive to other useful purposes, independent of the indirect utility they are of to us, as furnishing the various nutritious and grateful edibles, known under the general name of fruit. Many of them, by their hard or fleshy coverings, are admirably adapted to protect the ripened seeds from drought or accidental injury. The decaying pulp of many offers a fine and fruitful soil for the first efforts of germination. While some of the drier kinds are so elastic, as of their own accord to scatter the seed far around its birth-place. Only slightly shake a stinging nettle on a dry autumn evening, and the elastic seed vessels will be seen and heard bursting open, and enveloping the place with the dust-like seed. The balsam, too—touch but its ripened capsule, it will recoil at your freedom, and disperse its seed to a considerable distance. The geranium is another instance: here each seed is attached to a spring, which flies out and jerks it afar off. The cyclamen is yet more curious. In this beautiful little plant the stalk of the capsule twists up like a spring, until the seed touches the ground; so also one species of the trefoil sows its own seed. The various orders of the flowerless or cryptogamic plants are full of these singular contrivances, and among flowering plants similar instances of wisdom and care are, on every side, most abundant, though space does not permit even an enumeration of them. One other, however, it would be wrong not to mention, though the production of a distant land, as in it we see a remarkable instance of the care of Providence in the preservation, distribution, and well-being of the seed, when thrown into its usual, and, as may be thought, calamitous circumstances.

The cocoa nut contains within itself sufficient nourishment to aid the development of its embryo, for a very long period, without the assistance of extraneous agents. The outer rind is fibrous, light, and matted; and formed somewhat like three boats joined together. Within this is a hard shell, with three eyes or holes to it. Then comes a nutty flesh, and in the centre of the whole a cavity filled with a milky liquid. Suppose such a nut falls into the sea—it floats—its fibrous coat imbibes moisture and sand—and the nut, assisted by the heat of a tropical sun, soon begins to grow. The first apparent sign is a yellow spongy body, formed within the nut. This soaks up a portion of the milk—roots grow from two of the holes in the hard shell, and run between the fibrous outer coat. Meantime the sponge increases—the milk diminishes, and the young shoot makes its appearance at the third hole. By and by the roots emerge from their confined bed, and become changed, as all roots do when exposed to disturbed water, into a long matted bunch of fine fibres. All this is not the work of a day, nor of a month; but the nut is being carried by the currents of the ocean far from its native shore, until at length being arrested in its course by one of those coral reefs, with which the Eastern seas abound, its numerous roots creep between the branches of the fragile coral—collect the sea weeds—interlace the sandy soil, and accumulate around a mass so solid, that it resists the most furious attacks of an angry ocean. The stem shoots upwards, and without any visible foundation for its roots, except that which it seems to have brought with it, or apparent means of subsistence for its broad expanding head, we find a tree, undisturbed by the lashings of the surge or the fury of the blast; a tree, too, rapid in growth, abundant in produce, and from which the savage islander derives not merely his food, but almost every implement he uses, and every luxury he enjoys.

PAPER KITES.

EVERY one is acquainted with the amusement of the paper kite, a very curious small machine, which in its mechanism displays great ingenuity. To some however it may appear astonishing that an object of this nature should form the subject of an academic memoir: for there is one on paper kites in the "Transactions of the Academy of Berlin," for the year 1756. But this surprise will cease when it is known that M. Euler was a profound geometrician, at an age when most young persons see nothing in the paper kite but an object of amusement: to him therefore it could hardly fail of being a subject of meditation. It presents indeed several curious questions, and which for the most part cannot be treated without the higher analysis. This memoir therefore may be ranked among the *juvenilia* of a great mathematician. We shall not follow him in his profound calculations; we shall content ourselves with treating the subject in a less rigorous manner, but much easier to be understood.

To analyse this amusement, and explain what takes place, let us suppose that A D represents the axis of the kite, to which is attached the cord E C, held at C by the person who directs it. Let F E be the direction of the wind, all the currents of which we suppose united in one, acting on the centre of gravity of the kite; and which, for the sake of simplifying, we shall suppose not to differ from that of the body itself, or to be very near it.



Let F E represent the force with which the wind, to which the kite is exposed, impels its surface in a perpendicular direction; draw E G perpendicular to that surface, and make E L a third proportional to E F and E G, and draw L M parallel to G F; E L will represent the force with which the wind impels the lower surface of the kite, in the perpendicular direction, and L M will be the effort exercised by this impulse in the direction M L or A E D.

We shall first observe, that by the latter the kite would tend to be precipitated downwards, but the angle A E C being acute, there thence results an effort in the direction E A, which counterbalances the former, otherwise the kite could not support itself, and this is the reason why this angle must necessarily be acute.

If we now make E H equal to E L, and draw E I perpendicular to the horizon, and H I perpendicular to E H, we shall have two new forces; one of which, I H, will act in the direction E D, and tend to throw down the kite: but this force is annihilated, as well as the former M L, by the power in C, which draws according to the acute angle A E C. The other, E I, is that which tends to make the kite rise in a vertical direction.

Hence, if the force E I be greater than the weight of the kite, it will be raised into the air, and if we suppose that the extremity of the cord is fixed in C, it will turn around the point C as it rises; but by turning in this manner it must necessarily happen that the wind will fall with more obliquity on its surface A D; so that there will at length be an equilibrium. The kite then will rise no farther, unless the cord is let out; in which case it will rise parallel to itself, and as in ascending it will meet with freer air and stronger wind, it will still turn a little around the angle C; or the angle C will become greater, and approach more and more to a right angle.

Such is the mechanism by which the paper kite rises into the air. It may be readily seen, that if the velocity of the wind, with the surface and weight of the kite, be known, as well as the constant value of the angle A E C, the height to which it will rise may be determined.

A question, which here naturally presents itself, is, what ought to be the value of the angle A E F, in order that the small machine may rise with the greatest facility? We shall not give the analysis of this question, but shall only say, that if the wind be horizontal, this angle must be 54° 44′, or the same which a rudder of a ship ought to make with the keel, that the vessel may be turned with the greatest facility, supposing the currents of water which impel it to have a direction parallel to the keel.

We shall here observe, that it is not absolutely necessary that the angle A E C should be invariable, and determined to be such, by a small cord proceeding from a point of C E to another point near the head; but, in this case, the point E, where this cord is attached to the kite, must not be the same as the centre of gravity of the surface of the kite, and the centre of gravity must be as far as possible towards the centre of the tail D. It is for this reason, that a cord with bits of paper fixed in it is added to the point D; by which means the centre of gravity is thrown towards that point. Those who amuse themselves with kites, were certainly not conducted to this mode of construction *à priori*: the origin of this appendage must have been a desire to give to the small machine the appearance of a bird with a long tail, balancing itself in the air. But accident on this occasion has been of great utility; for M. Euler found by a calculation, of which no idea can be here given, that this small tail contributes a great deal to the elevation of the kite.

In short, this amusement, however frivolous it may appear, presents some other mechanical considerations which require a great deal of address, and a very intricate calculation.

A NEW LIFE-BOAT.

MR. ANDREW HENNESSY, of Cork, a very successful ship builder, has invented a life-boat, which not only combines all the improvements heretofore known, but possesses original claims peculiarly its own. The following is the description of the boat:—

"The safety-boat can be formed of any size, from the sculler on the Thames to the launch of a first-rate man-of-war. This at present to be alluded to is 33 feet to a straight rabbet, 6½ feet beam, and 5½ feet deep, capable of conveying sixty-six passengers with a crew of six, with every other requisite for future preservation after quitting the vessel. The boat in all its parts is perfectly elastic, except about three-fourths of its keel, which is secured by three bars or plates of copper or iron—one plate on each side of the keel, and one on the flat at bottom. These plates are of sufficient substance to give strength and stability, and help to act as a preponderating medium against the danger of upsetting, together with the precautions that are taken in the interior, so that it can never upset by accident; but if compelled to it by way of experiment, it will right itself in an instant, without injury to crew or passengers, or admitting one drop of water. The stem and other parts of the keel are secured by thinner plates in joints neatly fitted one within the other, so as to give strength to these parts, still preserving their elasticity, that being the grand principle upon which the whole structure depends. The timbers, which are very slight, are of oak, tarred and parcelled with light strong canvass, with a casing over that of thin whalebone, taken out of a stove or boiling pan, then served like a rope with a spun yarn, and the outside finished with leather or improved canvass sewed on; by being secured in this manner they become of great strength, and are perfectly elastic; and though bent any way they never lose their form, a most essential property, as they are removed at pleasure when the boat is stowed away. The covering or skin, in place of plank, is a kind of cloth—the result of long and arduous application, his sole invention. It is of great strength and durability, and perfectly water-proof; for additional strength and security, there are two skins of this fabric, graduating in thickness from the outside inwards, so as to prevent any possibility not only of water, but any damp coming through. The materials of this cloth are saturated with a chemical process in the loom, which preserves it from wet and the action of the atmosphere; it always preserves its pliability, and will not heat, mildew, or rot. As a proof of the perfection which this manufacture is brought to, the inventor has converted some of the thinner kind into the upper part of shoes, which is much cheaper than leather, and far more durable. The boat has two pair of gunwales, secured the same as the timbers, all the heads of which are received and steadied by the first pair, and the other pair lashes and fastens to the first, which keeps the timbers in place, and perfectly secure. The covering, or skin, is secured to the keel, and brought to the gunwales, the same as a sail laces to a yard; so that, at first view, it comes within the comprehension of a seamen, to put into form or take it asunder. It is decked, or covered, with the same cloth or skin: the deck laces through the centre, fore and aft, from stem to stern-post; in this joining there are laps or doublings, which effectually exclude any water from getting in. There is a hollow tube comes through the deck, which answers for a mast-step, and gives air to the persons in the interior of the boat. The oarsmen sit on their thwarts, which are of cloth through the deck, from which coats are erected, the same as the coat of a mast or pump, which are neatly fitted by plates to their bodies, and buckle below their breasts. From the construction of the safety-boat it becomes portable; the gunwales and deck-support slip up; of the stem and post, the timber ceiling, &c., all come out, and the skin folds together or rolls up the keel, so that it occupies but little space, and can be put together in a few minutes when wanted. There is no danger or casualty that the present boat, or life-boat, is liable to, but is guarded against in this, and every certainty of saving life from the vessel lost in the ocean, as well as the vessel lost on the rock or the shore."

MISCELLANEOUS EXPERIMENTS.

Melt sulphur in a small iron ladle, and carry it into a dark room in the state of fusion. If an ounce or two of copper filings be now thrown in, *light will be evolved.*

If a little nitro-muriate of gold be added to a fresh solution of muriate of tin, both being much diluted with water, the gold will be precipitated of a purple color, forming that beautiful pigment called *Powder of Cassius.*

If a colorless solution of galls be added to a solution of bismuth in nitric acid, equally colorless, a *brown* precipitate will be produced. This is a distinguishing *characteristic of this metal.*

If a solution of the green sulphate of iron be dropped into a nitro-muriate of gold, the last metal will be immediately precipitated. In this state it is often employed in *gilding China.*

To a solution of gold add about a fourth part of ether; shake them together, and wait till the fluids separate; the upper stratum, or ethereal gold, is then to be carefully poured off into another vessel. If any polished steel instrument or utensil be dipped into this solution, and instantly plunged into water, the surface will have acquired a coat of pure gold, being a very elegant and economical mode of *preserving polished steel from rust.*

Prepare a very dilute and colorless solution of platina by dropping a small quantity of the nitro-muriate of that metal into a glass of water. If a single drop of the solution of muriate of tin be added to this, a bright red precipitate will be instantly produced. A more *delicate test* than this of any metal cannot be conceived.

If a morsel of the dried crystals of nitrate of silver (not the lunar caustic) be laid on a piece of burning charcoal, the metallic salt will immediately deflagrate, throw out the most beautiful scintillations that can be imagined, and the surface of the *charcoal* will be richly *coated with metallic silver.*

Drop a piece of phosphorus about the size of a pea into a tumbler of hot water, and from a bladder, furnished with a stop cock, force a stream of oxygen gas directly upon it. This will afford the most *brilliant combustion under water* that can be imagined.

Dissolve a few crystals of nitro-muriate of gold in about eight times their weight of pure water; place a thin slip of charcoal in the solution, and heat the whole by means of a sand-bath. When the solution has acquired nearly a boiling heat, the gold will precipitate itself on the charcoal, in its metallic splendour, forming a singular and beautiful appearance. This experiment is designed to show that *metals* become *insoluble*, the moment they *impart their oxygen* to foreign bodies.

Proceed as in the last experiment, and submit the vessel with its contents to the rays of the sun. Here the metal will be reduced, and the charcoal as effectually gilt as before. This is illustrative of the *deoxidizing power of the sun's rays.*

If a little colorless and recently prepared muriate of tin be poured into a rich *green* solution of muriate of copper, the copper will be deprived of a portion of its oxygen, and a *white muriate of copper precipitated.*

Procure some solution of sulphate of iron at the *minimum* of oxidizement, by digesting iron filings with the common sulphate. Into this, when filtered, drop a little of the solution of prussiate of potass, and a *white prussiate of iron* will be precipitated.

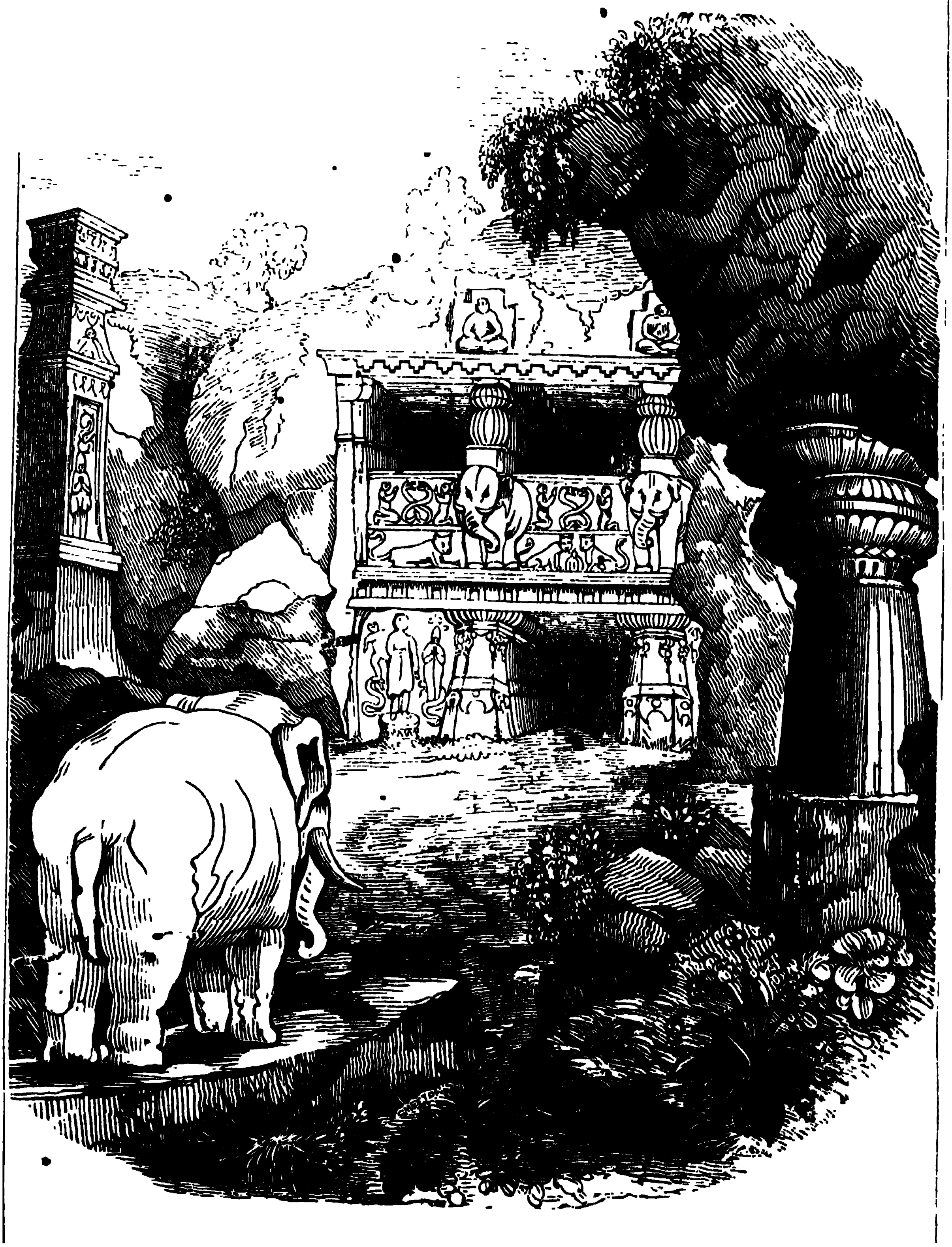
Pour some pure nitric acid on the black oxide of manganese, and no solution will be effected. But if a little sugar be added, the *sugar* will *abstract* a part of the *oxygen* from the oxide of manganese, and the acid will then be enabled to dissolve the metal.

Expose an ounce of nitric acid for an hour, in an open phial, to the direct rays of the sun, and pour another ounce of the same acid, that has not been so exposed, into another phial. If a little of the black oxide of manganese be now put into each, *the oxide* in the *first phial* will be *dissolved*, while that in *the other* will *not be affected* by the acid.

Dissolve some oxide of nickel in caustic ammonia, which will produce a solution of a rich *blue* color. By exposure to the air this gradually changes to a *purple*, and lastly to a *violet*. The addition of an acid will, however, convert the whole to a *green.*

When antimony is heated to whiteness in a crucible, and in this state agitated, in contact with the air, it inflames with a sort of explosion, and presents while burning a very singular kind of *white flame*, forming what have been formerly called *argentine flowers.*

If alcohol contains muriate of magnesia, it has the property of burning with a *reddish yellow flame.*



CAVERN TEMPLES OF INDIA.

CAVERN TEMPLES OF INDIA.

THE architecture of the ancient Hindoos appears to have been derived from the same ideas as the Egyptian. The most remarkable relics of this people are their subterraneous temples of vast size, and elaborate workmanship, carved out of the solid rock at Elephanta, Ellora, and Salsette. Compare the excavated temples of India with the constructed ones of Egypt, and their resemblance will be found most striking. In both these styles are found close intercolumniations, low and short architraves, and columns of short statue, rudely sculptured.

The caves of Elephanta, which is a small island in the harbour of Bombay, are most elaborated for their interior beauty—those of Ellora for their exterior. Ellora is a Hindoo village, situated in the mountains, about 15 miles from Aurungabad. For the space of nearly 2 leagues there is scarcely anything but a series of these excavated temples, in which there are thousands of figures, appearing from the style of their sculpture to have been of ancient Hindoo origin. At Salsette, an island near Bombay, is an excavated temple hewn out of the solid rock, of four stories or galleries, in which there are 300 apartments. These apartments have generally an interior recess or sanctuary, and a small tank for ablution. In these recesses, as at Elephanta, are representations of Hindoo deities. The ground pagoda is 40 feet high to the soffit or flat part of the dome; it is 84 feet long, and 46 broad. The portico has fine columns, decorated with bases and capitals. Immediately before the entrance to the grand temple are two colossal statues, 27 feet high; 35 pillars of an octagonal form, about 5 feet diameter, support the arched roof of the temple, their bases and capitals are composed of elephants, horses, and tigers, carved with great exactness. Around the walls are two rows of cavities arranged with great regularity, for receiving lamps. At the farther end is an altar of a convex shape, 27 feet high, and 20 feet in diameter, round this are also recesses for lamps, and directly over it is a large concave dome, cut out of the rock. Immediately about this grand pagoda there are said to be 90 figures of idols, and not less than 600 within the precincts of the excavations.

But magnificent as these excavations must be, they are surpassed by those of Ellora, the general character of which may be learnt from the illustrative cut, which represents a portion of them. There are, in and near this place, no less than about 20 of these caves, of which Sir C. Mallet describes 16 in a paper inserted in the sixth volume of "The Transactions of the Asiatic Society." Of these we must, of course, confine ourselves to a general idea of their architecture. With this view we have selected for engraving a portion of several of these caves—the principal in size, and most beautiful of which are those of Jugnath Subba and Keylas.

The first of these, which faces the S.E., is represented at the back of the view, the long ranges of pillars supporting the ceiling; the elaborately carved pillars themselves; the upper ones supported by elephants; the rich fringe and cornice, and the figures of seated Hindoos which surmount the cornice, like acroterions in the Greek buildings; all show very considerable skill and perseverance, cut out, as the whole of them are, from the solid rock.

The large column, or rather the pillar to the right of the cut, is taken from another of these temples, and exhibits in a striking manner the peculiar character of ancient Indian columns. The capital, it will be observed, is formed like one or more cushions, which it may be imagined that the weight above has flattened. The shaft is regularly fluted, and the base is a massive block.

The elephant appears to be no less an object of importance at Ellora than at Elephanta, where it is carved in relief on all the sides of the excavations, and stands in relief on the floor. A huge one of the latter kind is seen on the floor of another of these caves, called Indur Subba, and is represented on the left of the cut; behind which, is situated an obelisk of elegant and light formation, not unlike the Egyptian obelisk, with plain sides, sculptured with hieroglyphics, but covered with panels and mouldings, which display considerable taste. This is from the cave of Keylas, and is supposed to have been surmounted with a lion.

The above remarks, giving a general sketch of the cavern architecture of India, will, it is hoped, be sufficient to impress upon the mind some idea of their peculiar character. To enter more fully into this subject would scarcely be compatible with our design, and we may add scarcely useful, considering that the style, however admirable for a rude, uncivilized people, cannot now be made subservient to our architectural wants, nor adapt itself to the totally different requirements of our religion, nor is it likely to be applied to, even for the improvement of those architectural principles which the Greeks afterwards so fully established.

ANIMAL MAGNETISM.

(Resumed from page 165, and concluded.)

FROM the time of the report of the commissioners relative to this subject, which we have already given, it remained dormant until a few years since, when it made some stir in the French capital, under the auspices of Dupontet and others; and so extraordinary were the facts stated, such as teeth being extracted, and the operation of cancer being performed without the patient being aware of it, that the faculty of medicine instituted a second commission of inquiry, and afterwards a third. The conclusion to which they all of them came was, that the whole was a system of fraud on the one part, and either extraordinary insensibility to pain, or facility of inducing epilepsy on the [illegible]—that animal magnetism, if true, took effect only upon a [illegible] persons, and those of weak nerves or ill state of health, and that it proves of no benefit whatever, even supposing it to be real in the cure of either bodily or mental disease.

The facts insisted upon in this country by Dr. Elliotson, two years since, and the experiments of M. Delafontaine at present only confirm more strongly the above opinion. As the subject however has obtained some celebrity, we will give two abridged accounts of the proceedings of the present magnetiser.—One from the *Times*, which has certainly shown considerable credulity, and which mentions the bare effects as first witnessed; and the other account from the *Inventors' Advocate*, which has taken a more philosophical view of the matter; those who are further interested in the subject, may read with advantage the *Times* of the first week in August, particularly the letter of Mr. Edwin Lees, who in reference to the following account has shown with truth and sound medical knowledge, how even the following effects may arise from natural causes, independent of animal magnetism.

The *Times* of July 20, says—"Before entering upon the experiments, conducted at the Hanover Square Rooms, it will be as well to describe the operator, M. Delafontaine, himself. He is, we should say, about 40 years of age, about 5 feet 8 or 9, of rather austere, perhaps thoughtful, cast of countenance, his hair dark, worn somewhat *à la Brutus*, and his beard, to borrow an expression from Dominie Sampson, 'prodigious.' So far then for the lecturer—we proceed with his experiments. About a quarter after 3 he made his appearance on a raised stage at the end of one of the small rooms in the building. A youth now made his appearance, of a sallow olive complexion, but seemingly healthy, with dark hair and eyes, and rather good-looking. He was dressed in a black surtout, light white drill trousers, and boots, and we should think him about 17 or 18. He was then seated in an arm-chair, one of the common arm-chairs belonging to the rooms, and the mesmerismetic operations commenced. The operator took off his left-hand glove, drew a chair to the right of the youth, then placed his left thumb upon the apex of his (the youth's) right thumb, and two fingers on the fleshy part of the ball, and looked him steadily and fixedly in the face. It was about two or three minutes before any visible effects were produced, though immediately as he commenced, a sort of spasmodic motion took place in the youth's throat, the symptoms indicating the presence of what medical writers have designated *globus hystericus*. Shortly after the patient seemed lost to all consciousness, as, indeed, it was soon proved he was. But in the sleep into which he had been thrown the ordinary phenomena of sleep were not indicated. For example, his neck remained rigid, while his arms rested apparently flaccid at his sides, while no change could be detected in the features, except perhaps that his cheeks were a little more pallid (if this expression may be allowed, for it is not the word that expresses what we mean,) than when he took his seat. The somnambulism being now complete, the operator, to our horror, drove several pins forcibly into his head and cheeks; but the somnambulist gave no indications of sensation. In fact, he seemed dead, and the interest excited in the room was expressed in suppressed sighs. At this period we confess that we felt a little indignant at the supposed legerdemain which was being practised, but a very few moments convinced us of the injustice of our suspicions, and, we believe, of every other person in the room. A phial of concentrated ammonia, commonly called hartshorn, was then opened by M. Delafontaine, and handed to the company to test its strength; and so powerful was it, that no one could bear it within six or eight inches of his nose, yet this was applied closely; in fact, affixed to the nostrils of the somnambulist; yet he gave no sign whatever of his suffering from it, and was decidedly unconscious of its presence. Next some lucifer matches were lighted and placed under his nose, the operator closing his mouth with his hand, but neither did these produce any effect. But on M. Delafontaine partially unsomnambulising him he drew back his head when the phial was held to his nose. Being again subjected to the magnetic influence, several percussion caps were fired from a pistol close to his ear, on both sides, and over the crown of his head, and at the occiput, and before his face, but he gave no start, or even moved a fibre. He was then partially awakened again, and started at the discharge of another percussion cap. Being again manipulated, a perfect state of catalepsy was produced. His arms were extended horizontally from the shoulders, and his legs from the chair, and in this position the electro-magnetic current, from a powerful machine, was made to pass through him, which shook him dreadfully, but he gave no signs of feeling. We forgot, in the hurry of description, to say that previous to this experiment, having doubts of the catalepsis, we asked and obtained leave to feel the patient's pulse, but after a very careful examination, being determined to judge for ourselves, we could not detect any pulsation whatever. The arm was rigid, and could not be bent. It resisted like the bough of a tree, and, whether from fancy, agitation, or the magnetic fluid, we will not undertake to say which, we experienced a disagreeable sensation, which no words can express, and gladly, therefore, left the somnambulist for our seat. The somnambulist still in the chair, the company were invited to test the power of the electro-magnetic machine, but none seemed willing at first to subject themselves to its influence, till a gentleman, evidently from the country, if we might judge from his fine healthy looks, stepped forward and took the wires; but he had scarcely laid hold of them when he gave a shout that we shall never forget as long as we live. He declared that he was so overwhelmed with the shock that he could not let go the wires, and therefore shouted. The patient was next subjected to the voltaic battery. From this he seemed to suffer at first, but the operator declaring he had not been sufficiently magnetised, renewed the fluid, when, though the battery shook his arms like rattles, still he seemed quite unconscious of suffering. He was then blind-folded and covered with a cloth, that he might not by any possibility see who approached him, and several of the company thrust pins into his hands and thighs, but he remained insensible. He was then made to walk, leaning on the arm of a gentleman who volunteered to support him, when the operator standing at several yards distant, suddenly caused him to fall by a mere motion of the hand. This experiment seemed to alarm the gentleman on whose arm the somnambulist was leaning at the time he fell, and indeed it required all his exertions to keep his head from coming violently in contact with the floor, as it was, he saved him by the merest chance. When he was raised, which was done by the operator seizing him by the collar, the right arm, which had been resting for support on the gentleman's arm, was elevated and rigid, as if still in the position it occupied while walking, while the left foot was raised in the act of stepping out. Being at length unmagnetised, the youth seemed perfectly in health, and declared that he did not recollect anything that had happened to him. We have forgotten to mention that he was directed to sing during the period he was under magnetic influence, when he made a low moaning noise, coming as it were from the stomach, but which was arrested at will, by a single motion of the operator's hand."

The following account is given in the *Inventors' Advocate*, of August 14:—

"The operations on Thursday last, August 12, 1841, commenced by producing a boy about eight years old, who is deaf and dumb, whom M. Delafontaine proposed to place in a state of somnambulism, and, while in that state, to make him sensible of sound

"The boy was seated in an easy chair, and after M. Delafontaine had gazed earnestly in his face for a short time, whilst holding the boy's hands on his, he commenced the mesmeric manipulations. In the case of the boy, these manipulations consisted in stroking down his hair, drawing the hand over his face, and pointing the fingers to his eyes. The boy then closed his eyes, and though for a time he appeared to be asleep, it was soon evident that there was no mesmeric effect produced, for more than once he cried, and seemed frightened. M. Delafontaine then redoubled his manipulations; rose from his seat, opposite the boy, and stroked his head more assiduously; ever and anon placing his own fingers on the boy's ears, and moving them round. The heat and stillness of the room, and the soothing nature of the operations, were enough to induce sleep, and the boy appeared to be dormant. M. Delafontaine then shouted in his ear. The boy, however, gave no indication of perception. The manipulations were repeated for some time with the same ill-success, when the boy was withdrawn. It was stated, to account for this failure, that it sometimes requires two or three sittings to induce the magnetic influence; and subsequent operations on the boy were promised.

"The youth upon whom M. Delafontaine usually operates was then introduced. He was recognised by some of the company as the person who had received the checks at the door. This circumstance was certainly calculated to raise suspicion of collusion.

"M. Delafontaine's mode of operating with him was very different from that adopted with the boy and with the gentleman whom he subsequently tried to subdue by magnetic influence. After holding the youth by the hand a short time, the operator commenced his manipulations by rapidly moving his hands at a short distance from the patient's face. He then patted the youth's stomach, towards which he directed many of the manipulations. These operations soon produced an effect on the patient, who opened and shut his mouth as if he were parched; frowned, and moved about uneasily. Occasionally he put his hand to his face, and uttered inarticulate sounds. M. Delafontaine did not, however, cease his manipulations, some of which from their violence had a rather ludicrous effect. He then produced a bottle of concentrated ammonia, which it was proposed to hold under the patient's nose for three minutes, to prove that he must inhale during the time. Some sceptical persons suggested that a handkerchief should be held over his mouth, to insure his breathing through his nostrils. This, however, owing to some disturbance, was not effectually done, and this part of the experiment in our opinion proved nothing. A burning brimstone match was next held under the patient's mouth; but as the time during which the brimstone was consumed was very short, this part of the experiment was also unsatisfactory: breathing might have been easily suspended for a longer time. The next part of the experiment consisted in sticking pins into different parts of the youth's face, and even into his nose. The pins were left sticking in his face as in a pin-cushion, but they did not draw blood. At one time the youth winced, when M. Delafontaine exclaimed in French, 'he feels!' and thereupon renewed his manipulations, to induce a more profound state of somnambulism. It is a curiosity worth noticing, that when pins have been stuck into this youth by other parties blood has followed the punctures, but M. Delafontaine's pins produced none. The patient's arms and legs were then rigidly distended for a length of time, though it was noticed by some medical men that the limbs gradually relaxed before they were unmagnetised.

"The experiment with the voltaic bttery was not tried, because, notwithstanding all the manipulations, the patient was not in a mood favorable to magnetic influence. Nothing, however, could be more easy than to practice deception by pretending to pass an electric current through the body; therefore had the experiment succeeded it would not have tended one iota to remove our scepticism. By a great many active flourishes of the hand M. Delafontaine succeeded in restoring animation to the patient, and he was led out; some of the audience encouraging him as he went by the very equivocal compliment of applause.

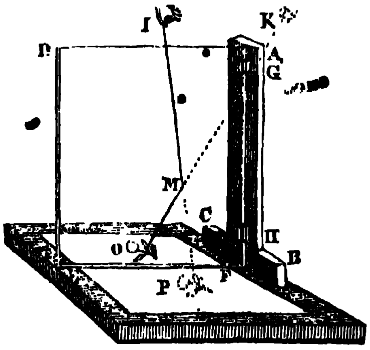
"Several gentlemen then volunteered to be operated on. The first announced himself to be a Fellow of King's College, Cambridge. He was placed in the chair. M. Delafontaine sat opposite to him, and taking hold of his hands, fixed his eyes steadily on those of the patient, with the intent, as appeared, to overpower him by the mysterious influence which it is known to every one is exerted by the human eye steadily directed. The Fellow of King's College, however, fixed his eyes as steadily on those of the operator, and was not to be put out of countenance. This continued for about ten minutes, without a word being spoken or a sound made in the room. M. Delafontaine gradually advanced his fixed eyes nearer and nearer to those of the patient, but the latter appeared to have an equal chance of magnetising the operator. At length M. Delafontaine directed the points of his fingers to the patient's eyes; and, bringing them close to his face, obliged him to close the lids. This action was continued, and it became doubtful whether the magnetic influence had not taken effect. In half an hour's time the patient was spoken to, when he immediately replied, and M. Delafontaine admitted the experiment had failed. The gentleman said he had experienced no effect from the operation, only he was rather 'giddy' by having the eyes of M. Delafontaine fixed so long upon him. Two other gentlemen were tried, and underwent the same gazings and manipulations, without any better effect. It was then announced that M. Delafontaine was exhausted, and that no further experiments could be made. General dissatisfaction prevailed in the room, and a great deal of disputation took place among the gentlemen on the platform.

"The impression produced on us by what we saw at this exhibition was decidedly unfavorable to the claims of animal magnetism as a science. If its pretentions be well founded, never, surely, did truth present itself in so suspicious a form. The fact that the youth operated on is in the employ of the operator, and the high price charged for admission, present strong *primâ facie* evidence of collusion and imposture; and the immense beard and mustachios of the professor of the new science are, to English eyes, the guise of charlatanery."

A SIMPLE CAMERA LUCIDA.

Has recently been invented by Sir John Robison, late Secretary to the Royal Society of Edinburgh. This camera is remarkably cheap, easily constructed, and peculiarly applicable to the delineation of fruits, flowers, bulbs, seeds, and other small objects. It was exhibited to the Edinburgh Society of Arts, on March 8th, 1811. "Something similar," Sir John Robison observes, "was suggested to me, some years since, by the Rev. Mr. Taylor, of York, but it had escaped my memory until lately; when, looking at some plants confined in a frame of plate glass, I was struck with the vivid images of the plants reflected from the bright plates, at such an angle as permitted vision of objects through them. This recalled Mr. Taylor's suggestion, and showed how it might be made available for copying natural flowers and other small objects."

The figure represents a piece of thin plate-glass, A D E F, set upright on a drawing-board, by means of a wooden standard, A B C, in a groove in which the edge of the plate is retained by the wedges G and H. The wooden standard is not fixed to the drawing-board, and may be set on it in any convenient position. To use this apparatus, it is placed in front of the artist, with the standard A B C towards him; the object to be copied is laid on the left-hand side of the plate, as at O; the head of the observer being also a little to the left of the pillar, and the eye directed towards the middle of the plate, as at M, a distinct image of the object O will be perceived, as if it lay on the paper at P; and as, at the same time, a pencil held on the right-hand side of the plate will be equally visible, it may be applied to trace the image at P.



Some attention is required in selecting a favorable position for the apparatus, in respect to the illumination of the object, and its admitting only such a degree of light to the paper on the right-hand side of the glass, as may give sufficient distinctness to the point of the pencil, by which precaution the reflected image is seen to most advantage.

It must be recollected, that the delineation will not represent the original object as beheld by direct vision by an eye placed at I, being that of a reflected image, similar to what would be seen by direct vision, if the eye had been situated at K.

ENGRAVING.

(Resumed from page 175.)

Process of Etching.—This art so pleasant and easy in practice, and strong in effect, is divided into five parts:—1. The preparation of the copper or steel plate. 2. The transferring upon it the intended design. 3. Etching, or scratching in that design. 4. *Biting in* with acid, so as to render the design permanent. 5. Clearing and touching up the plate previous to printing from it.

P. The preparation of the plate, or laying upon it an etching ground, &c. First take care that the plate is perfectly clean and bright, and without scratches, otherwise take the scratches out with the burnisher, and clean the plate with a leather and whitening. Then screw a handvice on to one corner or edge of it, guarding the face of the plate with a piece of paper doubled; this is necessary to prevent the teeth of the vice from indenting the plate, and thereby injuring it. Then have ready for immediate use the twisted wax taper, the etching ground, the dabber, and a sheet or two of waste paper, loosely folded up, so that when lighted it may give a large flame. Hold the plate in the left hand by means of the vice, the back of the plate being downwards, and lighting the paper hold it under the plate, until the whole of it is heated sufficiently and equally, in order to do which the flame must be moved about. The required heat may be known by turning the plate up, and holding it slanting, suffer a drop of water from the mouth to fall upon it; if this run off in the same way as it does from a hot laundress' iron, the plate is sufficiently heated. This being the case, put the plate face upwards (but without removing the vice,) upon a quire of paper, a book, the table, or some other substance which will not rapidly deprive it of its heat. Then take the etching ground, which is supposed to have been previously tied up in a piece of silk, and rub it on the face of the hot plate until a small quantity only is separated. The dabber is then required to lay the ground equally all over the plate, which is done by a dabbing motion. The thinner the coat of ground is, so much the better, provided it be equally distributed, and completely cover the surface of the copper.

While the plate still remains hot, light the taper, and holding the plate as at first, except that the face is to be downwards, suffer the smoke, arising from the taper, to spread itself over the surface, until the latter becomes of a smoke color, or nearly black; when this is the case, the plate is prepared ready for use, and when it has been suffered to get cold, the ground will be found sufficiently hard, not to be wiped off, and of a fine glossy surface. This operation is very simple, and takes less time in the execution than it does in the description. The rapidity indeed with which it is done, will be the principal means of insuring its success, for if the plate should happen to get too cold during the laying the ground previous to smoking it, the consequence will be that the smoked surface instead of being glossy will be dull, as if covered with smoke in a dry state; this is a sign that the ground is burnt, and if such burning extends far over it, or is in an important part, the whole must be washed off with spirits of turpentine, and the process recommenced. To avoid the possibility of this, the plate may be heated a second time by paper, immediately previous to the smoking. Let not, however, the plate be too much heated in the first instance, because if so, the ground, when applied to it, will bubble up and be spoiled. Another hint to the beginner may be necessary, and that is to be careful whenever heating the plate a second time, not to let any particles of the burnt paper settle upon it, which is particularly apt to be the case, because dabbing the ground (which is a resinous substance,) an electrical action is produced, the ground is excited, and attracts from a considerable distance any light floating substances. So, also, in laying the plate after the operation to get cool, care must be taken to preserve it from dust, as every particle, be it ever so minute, will take up the ground upon which it falls, and occasion a speck in the etching. If any defect should appear in the plate after it has been smoked, it is in vain to attempt to heat it, and then dab up the same ground again; when once finished it must remain with all defects, or else an entire new ground must be laid on. We have been thus particular because much of the success of other parts of the process depends upon laying a good ground, and the student had much better lay twenty grounds one after the other, that fail in the biting in, and find all his labour of drawing thrown away by his ground breaking up, when the requisite acid is afterwards poured upon it, and this is by no means an uncommon circumstance if the ground be either ill made, or ill laid on.

The next process is transferring the design to the ground; this is very easy. First draw the design intended to be etched on a piece of paper, with fine lines, but rather a soft pencil. When finished, damp the drawing slightly by wetting it for a few minutes between some sheets of damp paper.—Thus damped lay it in the proper position, face downwards, on the ground of the plate, and putting a sheet of the other damp paper over it, pass it through the copper-plate printer's press with rather a tight pressure, not, however, too tight, lest the ground should be disturbed. Taking it out it will be found that the greater part of the black-lead has left the drawing and adheres to the plate, making the exact counterpart of the drawing, but reversed. If there is not a copper-plate press at hand, a small design may very easily be transferred by putting a sheet of *dry* paper upon the damp drawing, and rubbing it with the smooth part of the ivory handle of a dinner knife or fork. The design being thus transferred, the next object is to prevent the hand from injuring it during the etching; to do this most readily cut up the cover of a book into slips, half an inch wide, or else fold up a piece of paper to form about the same thickness, and stick two of these slips or rolls of paper one on each side of the plate, then laying a thin strip of wood across the guard or slips, the hand will rest upon these without danger of injuring the drawing.

The third process is engraving or etching the transferred design. For this purpose take the etching point, and using it exactly as you would a pencil, trace over all the lines of the drawing, so as clearly to lay bare the surface of the copper beneath, and, in fact, to scratch a minute distance into it.—For this a greater pressure is scarcely required than would be upon the pen or pencil in writing. The finer lines may be done with a fine point, the fuller lines with one that is blunter, though very many engravers use the same point upon all occasions—depending for greater delicacy or breadth of effect upon the after process of biting in. When the whole of the lines have been thus etched, the plate will have the exact appearance of a drawing. It must now be examined for errors and scratches, and taking a small, fine camel-hair pencil, holding a little Brunswick black, properly tempered with spirits of turpentine, and previously poured out on a slab, every speck, scratch, error or defect of whatever nature, must be painted over with the black. This being done, the plate dry, and the guards from the edges of it removed, it will be ready for biting in. As this is the most difficult part of the process, and requires minute instructions, we must defer it till another opportunity.

(To be continued.)

OZONE, OR THE ODOUR OF ELECTRICITY.

(Proceedings of the British Association.)

F. De Moleyns, Esq., M.A., F.G.S., read a paper entitled "Some Researches on the Development of Electrical Force." Part the 1st, An Inquiry into the Nature and Properties of the New Element or Product of Electrical Action, described by Schönbein. Part 2d, On the Discovery of a Voltaic Combination of Extraordinary Energy.

Mr. De Moleyns commenced by observing—"We are on the eve of some extraordinary discoveries in electro-chemical science, which will most probably effect an entire change in the views of chemical relations at present entertained, there can scarcely exist a doubt. The doctrine of substitutions of Dumas—the strong proofs of the identity of silicon and carbon—the fact of the capability of the same body to crystallise in forms belonging to two different systems—the observations of Schönbein which formed the groundword of the first part of the subject of the present paper, with various other singular results recently obtained by eminent philosophers, fully sanctioned this opinion. The interesting character of the facts newly brought to light, and the confessed inadequacy of the various theories presented to the world since the commencement of the present century to explain or reconcile these modern results of laborious investigation, furnished good ground for fresh inquiry, and encouraged new laborers to enter the field of science." Mr. De Moleyns proceeded to say, that the statement made by Professor Schönbein at the Glasgow Meeting, respecting the production of a new element which he called *Ozone*, early attracted his attention, from his having, in the course of his electrical experiments, been struck by the singularity of the peculiar odour which the power of the batteries he employed produced to such a degree as to determine him, if possible, to solve the mystery. The paper now read contained some of the more important results he had obtained. In the report alluded to, which was read at the Glasgow Meeting, Professor Schönbein stated that the disengagement of the "odorous substance" depended, first—Upon the nature of the positive electrodes; second—Upon the chemical constitution of the electrolytic fluid; and third—Upon the temperature of that fluid. He added, that his experiments went to show that well cleaned gold and platina were alone capable of disengaging the odoriferous principle, and that the more easily oxidable metals, as well as charcoal, did not possess that property at all. The results of Mr. De Moleyns's investigations fully proved:—1. That the disengagement of the peculiar odour was not confined to the less easily oxidable metals. 2. That by certain arrangements all metals, when positive electrodes, may be made to develope the odoriferous principle. 3. That certain positive metals, not acting as electrodes, will evolve this principle. 4. That charcoal forms no exception to this rule. 5. That all substances, whether crystalline in structure or otherwise, possessing the property of appearing luminous by friction, or of yielding sparks when struck, also possess the property of discharging, under such circumstances, the "peculiar odour." 6. That iron and nickel develope this principle much more strongly than any other metal.

It was easy to account for Schönbein's error, in stating that gold and platina only developed the odour for he applied but one mode of evolving the principle, namely, by using the substances on which he experimented as positive electrodes in electrolytic fluids; it was, therefore, clear, that if, as he stated, even gold and platina produced the odour when clean, it must have been next to an impossibility for the professor to have evolved it from metals with surfaces more easily oxidable, and, therefore, in a condition to conceal rather than develope so subtle an element. There was no doubt of its evolution from all the metals employed by the professor; but there was as little doubt, that immediately on its disengagement, combination ensued with the particles of the film enveloping the ill-cleaned surfaces of the inferior metals, and thus that all evidence of its existence vanished. Mr. De Moleyns, considering the possibility of such an obstruction to the disengagement of the odour, contrived an apparatus by which he applied friction to the source of the positive electrode, and in every case found that the odour was evolved more or less strongly. Schönbein's opinion that ozone was the electro-negative element of an electrolytic compound existing not only in aqueous fluids, but also in the atmosphere, made it a point of much importance to ascertain if it could be produced in dry air or *in vacuo*. The professor himself had remarked that "problems of the highest scientific importance would be raised, in case it should appear that ozone could be produced in dry air." Mr. De Moleyns accordingly devised various experiments for the purpose of determining that interesting question, some of which he described in his paper. He stated, that observing the odour to be produced at the points connecting an electro-magnetic machine with the battery, he constructed an apparatus by which magnets were made to revolve within a glass cylinder, which could be exhausted at pleasure, or filled with various gases; by such means he obtained a vacuum, and operated in dry air, collecting the matters evolved over distilled water, and by such modes he clearly proved that ozone could not only be produced in a dry atmosphere, but also in a vacuum, mercurial and common. In several instances where distilled water had been admitted into the exhausted tube containing the odour, there was a much larger portion of the tube unoccupied by the water than calculation gave as the maximum space for the residual air after exhaustion; thus proving that ozone had been concentrated, or reduced to a substantial condition. On opening the tubes the odour was scarcely bearable, and diffused itself quickly, causing the same sulphureous smell as that prevailing in a place struck by lightning. These experiments, varied and frequently repeated with similar results, led Mr. De Moleyns to the conclusion, which he hoped would also be entertained by the Section, that the ozone of Schönbein—which he proposed to name Electrogen—must be admitted into the list of supposed elements; that it was not, as developed by Schönbein and himself, an union of an electrolytic compound whose cation was unknown; and that probably it existed in combination in various forms of matter, which at present are considered, but which, in reality, are not elementary. Mr. De Moleyns added, that he was still prosecuting these experiments, and was quite sure that the results already obtained would be followed by a succession of brilliant discoveries, proving the opinion at present entertained, concerning elementary substances to be sadly at variance with that beautiful simplicity which throughout the universe formed, and still forms, the ground-work of the operations of the great Author of our existence.

SUGGESTIONS ON MUSICAL STRINGS AND INSTRUMENTS.

BY LEWIS GOMPERTZ.

(To the Editor.)

SIR.—If the following suggestions on musical strings and instruments should seem of any value, or as leading to any improvement upon them, I should be glad of their insertion in your valuable work.

"It is known to many scientific persons, but not generally known, that in strings of the same material and quality no perceptible difference exists in the height of pitch to which they can be tuned; a bass string, if put on a violin, could be drawn up to the violin pitch, and would break at the same note that a violin string would if drawn tighter. If, in playing, either should be likely to break sooner than the other it would be the thin one, owing to the pressure of the bow; and the reason why all such strings would break on the same note is, that thick strings are like a number of thin strings joined together, each having its proportionate tension to the total, and if the whole string could be split after drawn up to its pitch into any number of parts, each filament would be the same note as the whole string; or if a string twice as thick as another is to to be drawn up to the same note, it would require twice the force, though both would be equally stretched, that is to say, if it require one coil round the peg to draw a string up to a certain note, and two coils to draw it up to another note, another string of the same quality, however thick or thin, would do the same, and never would the thickness cause any difference.

"It follows, then, from this, that the lower uncovered strings of violins, &c., being all of equal lengths, the highest string is most stretched, and the lowest the least; and this circumstance causes the higher strings to have a better tone than the lower, it being impossible to stretch the lower strings as much as the higher without drawing them up to the very same note, and if the lower strings are made still thicker, they become too stiff, without being in the least more on the stretch. An example of this is best shown on the double bass, the first string requiring a great many turns of the screw to draw it up to a pitch, and the third, though much thicker, very few; and it is, consequently, too abrupt, not being sufficiently elastic. But in harps and piano-fortes this defect does not exist, as in them the length of each string is, or ought to be, according to the note; and though thin bass strings are thicker than thin treble, the former do not owe their bassness to their thickness, but only to their length; though being longer, they are improved by being thicker too.

"When a good bass tone cannot be got from a string, whether of cat-gut, or silk, or wire, &c., it is found necessary *to load it* by covering it with wire, but the reason why this improves the tone seems not generally understood, it is chiefly that the covering adds to the weight without much increasing the strength of the string, and the additional weight, in order to vibrate the same note, must obtain the same force of spring from a thin string, as an uncovered thick string would produce from a thick substance, consequently, the thin covered string must be more stretched and more elastic than the other, and thus produce a better tone. But this is only owing to the want of more elasticity in the strings, to which quality alone they owe their vibrations; if strings were perfectly elastic no covering would be required, and then, even, very short strings might produce very low and good notes, as is the case with the small steel springs of musical boxes, and of accordions, &c., which, though very small, are so shaped as to produce good bass tones.

"It seems that the same notes from strings of the same material are better in proportion as they are longer, and that the length they can admit of depends on their strength, their specific gravity, and their elasticity. Steel and iron, then, being the strongest and lightest metals for strings, and being very elastic, are used for the treble notes of piano-fortes, but will not do so well for the bass notes, because the instruments are too short; the bass strings are therefore made of brass, which is weaker and heavier than steel or iron, and thus possess, in some degree, the qualities of covered strings, viz., of strings which have less strength and more weight; and in cabinet piano-fortes even brass is too stubborn for its weight, therefore, its extreme bass notes are produced by covered strings.

"But, in order to prove the effect of covering or loading a string, it might have *lead* wound round it after it is tuned, when it will be heard that the more lead there is the basser will be the note; and then, if wanted to draw up the string to the original note (as when unloaded), it must be the more stretched to produce it. In order, however, to remedy this defect complained of in the third string of the double bass, covered strings have been used, but owing to want of skill in this manufacture, they have been found to shrink and jar, and are therefore discarded. A better plan is by covering a small string with wire, and inclosing the whole in cat-gut, so that the string appears uncovered, but has the loading in the inside. It thus seems reasonable to think that strings might be made of *worm springs* of steel, &c., and that such strings, though very short, might produce good bass notes, as more spring would thereby be obtained, and great elasticity, which is all that is wanted for it. It appears also that if such a worm spring was placed behind the bridge, where the tail-piece is, and the common string was attached to this instead of the tail-piece, the same object would be partially obtained; but in this case it would be necessary to have a grooved wheel in the bridge for the string to bear on, to allow it to partake of the action of the spring, but the weight of the wheel would be some detriment, and the plan would not do for all the strings, as the bridge might then roll down. It seems, however, that both plans, and particularly the first, are worth a trial.'

(To be continued.)

NOTES ON THE MONTH OF OCTOBER.

Weather at	*Average of the Thermometer.*	*Average of the Barometer.*	*Rain in Inches.*
LONDON	52·81	29·69	2·027
EDINBURGH....	49·7	29·339	3·234
DUBLIN	51·	29·76	2·708

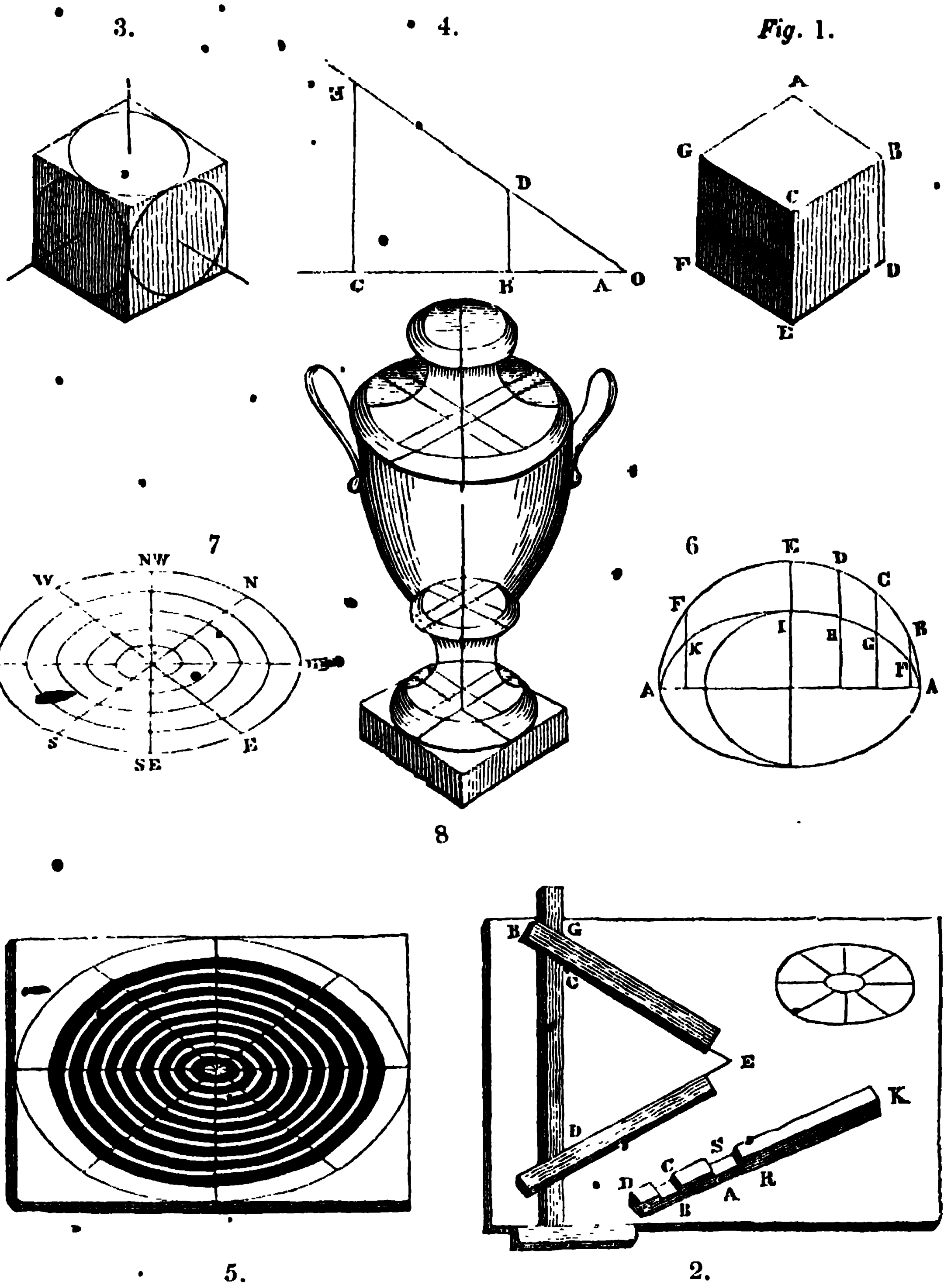
THE cessation of summer heat, the shortened days, heavy dews, and occasionally frosty nights, have, since the last month, played considerable ravages upon the face of nature, and upon the animals of the wilds and waters, all indicative of the coming winter. In the early part of the month Snakes and Vipers bury themselves preparatory to their long sleep. The greater number of the summer birds have already gone. The hen Chaffinch, however, now leaves us; the male still remaining in this country. According to the weather, so at different parts of the month various winter birds re-visit our shores. The Redwing arrives, as do also the Hooded Crows, the Wood-Pigeons, and towards the latter end of the month the Wood-Cock and the Snipe. Spiders webs hang on every bush and paling; now indeed is the only time when the entomologist can form a good collection of this insect—particularly the Gossamer Spider floats through the air in his delicate car of the finest web, which we may occasionally find floating over the fields in myriads. The Squirrel and the Nuthatch are in the early part of the month full of activity, the former in laying up his winter's store of provender. The little Nuthatch is also active, running up and down the trees, and pecking at the minute insects and their eggs, which are its favorite food. The Sea-Gull also visits inland parts.

VEGETABLE KINGDOM.

The decay of nature is no where more conspicuous than in the vegetable kingdom. Many trees have already lost their leaves, and others have them covered of those beautiful tints which distinguish autumn, and sometimes render the landscape scarcely less beautiful than in the spring. The leaves of the Ash, the Horse-Chesnut, and the Lime, are already fallen. Those of the Spanish Chesnut, yellow: of the Sugar-Maple, scarlet; of the common Birch, yellow and golden; of the Weeping Birch, golden and a bright scarlet; of the Marsh-Elder, a fine pink; of the Sumach, a purplish red; and of the Oak, various shades of yellow, orange, red, and purple. A few flowers may still be found even wild, and many more in the garden. Various annuals are yet in flower, as are also various of the Clematis tribe, and the Arbutus, upon which may, at the same time, be found both flowers and fruit. The chief ornaments remaining in the garden are various of the Michaelmas Daisies, the Rudbeckia tribe, the China-Aster, the Helianthus, or Sunflowers, and the Dahlia. Little, however, beyond these, remains to interest the botanist. Summer flowers are gone—the winter's Mosses and Lichens are not yet come to perfection; yet, he may devote some attention to the Fungus tribe with profit, as scarcely a wood, meadow, or hedge-row but contains numerous Agarics, Boleti, or some others of this interesting, but much-neglected tribe of plants.

GARDENING OPERATIONS.

The autumn, of which October may be considered the type, is, as is well known, a busy season with the gardener, not merely in gathering the remainder of his crops, but in clearing the ground from falling leaves, and his borders from decaying flowers. Other things press more immediately upon his attention than even these necessary employments. He must see that his greenhouses require no repair, and according to the weather remove into them his plants, which he is supposed to have arranged in his borders during the summer, fresh potting such of them as may be necessary. All his autumn planting should be executed as early in the month as possible. All deciduous shrubs may now be transplanted. Evergreens may be removed almost at any time; also border flowers, whether perennial or biennial, may be transplanted with success.



ISOMETRICAL PERSPECTIVE.

ISOMETRICAL PERSPECTIVE.

BY PROFESSOR FARISH.

(Abridged from the Transactions of the Cambridge Philosophical Society.)

"The kind of perspective which is the subject of this paper is much better adapted to the exhibition of machinery, and is preferable, on many accounts," says Professor Farish, "to common perspective. It is much easier and simpler in its principles. It is, also, by the help of a common drawing table and two rulers, incomparably more easy, and, consequently, more accurate in its application; insomuch, that there is no difficulty in giving an almost perfectly correct representation of any object adapted to this perspective, to which the artist has access, if he has a very simple knowledge of its principles, and a little practice.

"It further represents the straight lines which lie in the three principal directions, all on the same scale. The right angles contained by such lines are always represented either by angles of 60 degrees, or the supplement of 60 degrees. And this, though it might look like an objection, will appear to be none on the first sight of a drawing on these principles, by any person who has ever looked at a picture. For he cannot for a moment have a doubt, that the angle represented is a right angle, on inspection.

"And we may observe further, that an angle of 60 degrees is the easiest to draw of any angle in nature. It may be instantly found by any person who has a pair of compasses, and understands the first proposition of Euclid. The representation, also, of circles and wheels, and of the manner in which they act in one another, is very simple and intelligible. The principles of this perspective, which, from the peculiar circumstance of its exhibiting the lines in the three principal dimensions on the same scale, I denominate '*Isometrical*,' will be understood from the following detail:—

"Suppose a cube to be the object to be represented. The eye placed in the diagonal of the cube produced. The paper on which the drawing is to be made to be perpendicular to that diagonal, between the eye and the object, at a due proportional distance from each, according to the scale required. Let the distance of the eye, and, consequently, that of the paper, be indefinitely increased, so that the size of the object may be inconsiderable in respect of it.

"It is manifest, that all the lines drawn from any points of the object to the eye may be considered as perpendicular to the picture, which becomes, therefore, a species of orthographic projection. It is manifest, the projection will have for its outline an equiangular and equilateral hexagon, with two vertical sides, and an angle at the top and bottom. The other three lines will be radii drawn from the centre to the lowest angle, and to the two alternate angles; and all these lines and sides will be equal to each other both in the object and representation; and if any other lines parallel to any of the three radii should exist in the object, and be represented in the picture, their representations will bear to one another, and to the rest of the sides of the cube, the same proportion which the lines represented bear to one another in the object.

"If any one of them, therefore, be so taken as to bear any required proportion to *its* object, for example, 1 to 8, the others also will bear the same proportion to *their* objects; that is, the lines parallel to the three radii will be reduced to a scale.

"I omit the demonstration of this, and some other points, partly for the sake of brevity, and partly because a geometrician will find no difficulty in demonstrating them himself, from the nature of orthographic projection; and a person, who is not a geometrician, would have no interest in reading a demonstration.

"For the same reason, it is unnecessary to show that the three angles at the centre are equal to one another, and each equal to 120 degrees, twice the angle of an equilateral triangle; and the angle contained between any radius and side is 60 degrees, the supplement of the above, and equal to the angle of an equilateral triangle.

"In models and machines, most of the lines are actually in the three directions parallel to the sides of a cube, properly placed on the object. And the eye of the artist should be supposed to be placed at an indefinite distance, as before explained, in a diagonal of the cube produced.

DEFINITIONS.

"The last mentioned line may be called the *line of sight*.

"Let a certain point be assumed in the object, as, for example, C, Fig. 1, and be represented in the picture, to be called the *regulating point*.— Through that point on the picture may be drawn a vertical line, C E, and two others, C B, C G, containing with it, and with one another, angles of 120 degrees, to be called the *isometrical lines*, to be distinguished from one another by the names of the *vertical*, the *dexter*, and the *sinister* lines. And the two latter may be called by a common name— the *horizontal isometrical* lines. Any other lines, parallel to them, may be called respectively by the same names. The plane passing through the dexter and vertical lines, may be called the *dexter isometrical plane*; that passing through the vertical and sinister lines, the *sinister plane*; and that through the dexter and sinister lines, the *horizontal plane*.

"By the use of the following simple apparatus, Fig. 2, the representation of these lines in the objects may be drawn on the picture, and measured to a scale, with the utmost facility, the point at the extremity being first found, or assumed.* The po-

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"* It is unnecessary to describe the drawing-table any further than by observing, that it ought to be so contrived as to keep the paper steady on which the drawing is to be made.

"Here should be a ruler in the form of the letter T, to slide on one side of the drawing-table. The ruler should be kept, by small prominences on the under side, from being in immediate contact with the paper, to prevent its blotting the fresh drawn lines as it slides over them And a second ruler, by means of a groove near one end on its under side, should be made to slide on the first. The groove should be wider than the breadth of the first ruler, and so fitted, that the second may at pleasure be put into either of the two positions represented in the plate, Fig 2, so as to contain with the former ruler, in either position, an angle of 60 degrees. The groove should be of such a size, that when its shoulders, A and D, are in contact with, and rest against the edges of the first ruler, the edge of the second ruler should coincide with D E, the side of an equilateral triangle described on D G, a portion of the edge of the first ruler; and when the shoulders, B and C, rest against the edges of the first ruler, the edge of the second should lie along G E, the other side of the equilateral triangle. The second ruler should have a little foot at K, for the same purpose as the prominences on the first ruler, and both of them should have their edges divided into inches, and tenths, or eighths of inches.

'It would be convenient if the second ruler had also another groove, R S, so formed that when the shoulders, R and S, are in contact with the edges of the first ruler, the second should be at right angles to it For representing circles in their proper positions, the writer made use of the inner edge of rims cut out from cards, into isometrical ellipses, as represented in Fig. 5, of these he had a series of different sizes, corresponding to his wheels. Such a series might be sition of any point in the picture may be easily found, by measuring its three distances, namely, first, its perpendicular distance from the *regulating horizontal plane*, (that is, the horizontal plane passing through the regulating point,) secondly, the perpendicular distance of that point where the perpendicular meets the horizontal plane, from the regulating dexter line; and, thirdly, of the point where that perpendicular meets the dexter line from the regulating point; and then taking those distances reduced to the scale, first, along the dexter line, secondly, along the sinister line, and thirdly, along the vertical line, in the picture. These three may be called the *dexter distance* of the point, its *sinister distance*, and its *altitude*. And it is manifest they need not be taken in this order, but in any other that may be more convenient to the artist, there being six ways in which this operation may be varied.

" If any point in the same isometrical plane with the point required to be found, is already represented in the picture, that point may be assumed as a new regulating point, and the point required found by taking two distances; and if the new assumed regulating point is in the same isometrical line with the point, it is found by taking only one distance. And this last simple operation will be found in practice all that is necessary for the determination of most of the points required. Thus any parallelopiped, or any frame work, or other object with rafters or lines lying in the isometrical directions, may be most easily and accurately exhibited on any scale required. But if it be necessary to represent lines in other directions, they will not be on the same scale, but may be exhibited, if straight lines, by finding the extremities as above, and drawing the line from one to the other; or sometimes more readily in practice by help of an ellipse, as hereafter described.

" If a curved line be required, several points may be found sufficient to guide the artist to that degree of exactness which is required.

" The method of exhibiting the representations of any machines, or objects, the lines of which lie, as they generally do, in the isometrical directions; that is, parallel to the three directions of the lines of the cube, is as has been already shown; and likewise the mode of representing any other straight lines, by finding their extremities; or curved lines, by finding a number of points.

" But in representing machines and models, there are not only isometrical lines, but also many wheels working into each other, to be represented. These, for the most part, lie in the isometrical planes. And it is fortunate that the picture of a circle in any one of these planes is always an ellipse of the same form, whether the plane be horizontal, dexter, or sinister; yet they are easily distinguished from each other by the position in which they are placed on their axle, which is an isometrical line, always coinciding with the minor axis of the ellipse.

" This will be obvious from considering the picture of a cube with a circle inscribed in each of its planes, Fig. 3, and considering these circles as wheels on an axle. It further appears from the nature of orthographic projection, that the major axis of the ellipse is to the minor axis, as the longer to the shorter diagonal of the circumscribing parallelogram, that is, (since the shorter diagonal divides it into two equilateral triangles,) as the square root of three to one; as appears from Euclid, Lib. I. Prop. 47: and since the sum of the squares of the conjugate diameters in an ellipse is always the same, if we put $\sqrt{1}$ for the minor axis, the $\sqrt{3}$ for the major, and i for the isometrical diameter, we shall have $2\ i^2 = 1 + 3, = 4$, and $i = \sqrt{2}$.

" Therefore the minor axis, the isometrical diameter, and the major axis, may be represented respectively by $\sqrt{1}$, $\sqrt{2}$, $\sqrt{3}$, or nearly by 1, 1·4142, 1·7321; or more simply, though not so nearly, by 28, 40, 49.

" If in any case it should become necessary to represent a circle, which does not lie in an isometrical plane, we may observe that the major axis will be the same in whatever plane it lies; and it will be the picture of that diameter, which is the intersection of the circle with the plane parallel to the picture, passing through its centre. And the major axis will bear to the minor axis the proportion of radius to the sine of the inclination of the line of sight to the plane of the circle. We may observe further, that the diameters of the ellipse, which are to the major axis, as $\sqrt{2}$ to $\sqrt{3}$, when such exist, are isometrical lines.

" And the representation of every other line parallel, and equal to any diameter of the circle, may be exhibited by drawing it equal and parallel to the corresponding diameter in the ellipse. If it should be desired to divide the circumference of an ellipse into degrees, or any number of parts representing given divisions of the circle, it may be done by the following method:—

" Let an ellipse be drawn, Fig. 6, and on its major axis, A, G, a circle described, with its circumference divided into degree or parts in any desired proportion, at B, C, D, E, F, &c. from which points draw perpendiculars to the major axis. They will cut the periphery of the ellipse in corresponding points. It would be difficult, however, in this way, to mark, with sufficient accuracy, the degrees, which lie near the extremities of the major axis. But the defect may be supplied by transferring those degrees in a similar way, from a graduated circle, described on the minor axis. In this manner an isometrical ellipse may be formed into an isometrical circular instrument, or an isometrical compass, which may show bearings or measure angles on the picture, in the same manner as a real compass or circular instrument would do in nature.

" It may be often useful to have a scale to measure distances, not only in the isometrical directions, but in others also. And this may be done by a series of similar concentric ellipses, as in Fig. 7, dividing the isometrical diameters into equal portions. The other diameters will be so divided as to serve for a scale for all lines parallel to them respectively.

" Thus in the isometrical squares, exhibited in Fig. 1, distances measured on the longer diagonal, or its parallels, would be measured by the divisions on the major axis, those depending on the shorter diagonal by the divisions on the minor axis.

" To describe a cylinder lying in an isometrical direction, the circles at its extremities should be

cut by help of the concentric ellipses in Fig. 5: but he thinks that it would be an easier way to make use of that set of concentric ellipses as they stand, by putting them in the proper place under the picture, if the paper on which the drawing is made be thin enough for the lines to be traced through, as by the help of them the several concentric circles will go to the representation of one which might be drawn at once It is difficult to execute them separately with sufficient accuracy to make them correspond For this purpose a separate plate of Fig 5 should be had, and one edge of the paper on the drawing table should be loose to admit of the concentric ellipses being slid under it to the proper place.

represented by the proper isometrical ellipses, and two lines touching both should be drawn; and in a similar way, a cone, or frustum of a cone, may be described. A globe is represented by a circle, whose radius is the semi-major axis of the ellipse representing a great circle.

"It would not be difficult to devise rules for the representation of many other forms which might occur in objects to be represented. But the above cases are sufficient to include almost every thing which occurs in the representation of models, of machines, of philosophical instruments, and, indeed, of almost any regular production of art.

"To give such a representation of an Etruscan vase as would enable an artist to model it exactly, would be exceedingly easy. Let a vertical line be drawn to represent the axis of the vase, Fig. 8, and let points be taken in that axis, corresponding to the centres of the principal circles of the vase; through which the horizontal isometrical lines may be drawn, representing the radii of those circles, by the help of which the isometrical ellipses representing them are easily drawn. These will become a complete guide to the artist. He may assist himself by looking at the object along the line of sight, and then, if he has any skill in drawing he will find no difficulty in tracing the outline from one of these to the other, with sufficient correctness. If he is unskilled in the art, of course he must be at the trouble of finding a larger number of ellipses to guide him. And in a similar manner, any solid formed by the revolution of a plane figure round one of its sides may be represented." Other examples will be given on a future occasion, as well as more practical hints for the practice of this subject.

NATURE OF SOILS.

MINERAL SOILS.

1. *Clayey Soils.*—Although the word clay is commonly applied to any sort of earthy mass which can be formed into a compact ball by kneading it with water, it by no means follows that every earth which is so characterised is the same in other respects. Some sorts are exceedingly sterile, whilst others are fertile, and others are soft and ductile, and more readily part with water. Again, there are some sorts, such as pipe clay and fuller's earth, which are but slightly cohesive; others, again, are so extremely viscid and tenacious, as to be capable of being drawn out into threads; others imbibe water so readily, as to be easily cut with a sharp instrument; and others are so firm, hard, and compact, as scarcely to admit of being softened by means of water. Besides the difference of clayey soils in these respects, there is no less diversity in their colors and textures, they being found of various shades of red, blue, yellow, and white; and of all degrees of compactness and density. All fertile clayey soils are said to contain more or less lime in the state of carbonate; and in the red, blue, or yellow clays, termed *till*, there being no lime, and, at the same time, a large proportion of iron—they are very sterile. In all cases, indeed, clays are naturally barren, from their adhering together in masses, except in rare seasons, when summer is so divided between rain and sunshine, that they are kept in a medium degree between dryness and moisture. It has been proposed to improve soils of this kind in many different ways, so as to render them fit for the purposes of the gardener. One of the most effectual methods of improving a stiff clay soil in lightness, is repeatedly digging and stirring it, when it is neither too wet nor too dry; for, by stirring it when wet, it is more apt to be injured than ameliorated, the working rendering it more tough and cohesive, as is well known to brick makers, and in the potteries. Ridging up such soils during winter, to expose them to alternate frosts and thaws, though generally practised, is not always beneficial, for this renders some soils more stiff, while there can be no doubt it improves others. From these different and opposite effects having been locally observed, a question has arisen in books as to the utility of the practice. The problem can only be solved by trial; for even the most experienced could not, on mere inspection, tell whether a clay soil would be benefitted, or the contrary, by winter ridging. Sand or coal ashes, unless laid on in very great quantity, will in many cases have more tendency to bind clay soils together, than to loosen their texture; on the same principle that sand is employed to strengthen the cohesion of mortar. By far the most effectual way of ameliorating clay soils, is that recommended by the experienced Mr. Stafford, of thoroughly burning them, on the principle first brought into notice by Switzer, about a century ago. He forms a trench eight feet wide and three feet deep; filling it to the brim with faggots and brushwood, held down by roots of trees and stumps, according to the quantity of clay to be burnt. Taking advantage of fine weather, these materials are set on fire, and then the clay which has been dug out is piled up over the wood. As the fire becomes stronger, more clay is thrown on the heap, so as to form an embankment with the surface soil. In dry weather little if any additional fuel will be required, though it may be occasionally stirred. As soon as the fuel is burnt out, and the violence of the heat has subsided, he spreads out the burnt clay, taking care not to break the lumps. The burning may be conducted close to any crop, or tree, without danger; and clay cannot, he thinks, be burnt too much. The advantages are, that the burnt clay in the proportion of about one-third mixed with the other soil is rendered so rich, that no manure will be required for four or five years, and indeed it causes for the first two years rather too luxuriant a growth. The clay is rendered as pliable as burnt chalk, and is admirably fitted for holding just the requisite quantity of moisture, and no more, particularly if it be not broken too small or pulverized. It has the best effects in destroying wire worms, and other insects, as well as weeds; and "on whole quarters," he says, "where the process was performed years ago, I have scarcely observed either slug or snail."

2. *Sandy Soils.*—In soils denominated sandy, when the proportions of clay, loam, or other earthy substances, cause them to approach nearly to that of the sand, the heavier sorts of this description are formed. When these earthy materials enter only in small proportion, the light sandy soils are formed; and when there are hardly any of these earthy materials at all, the soil is a loose blowing sand, usually of a white or brownish color. The proportion of vegetable matters, intermixed with the different soils of the sandy kind, are not less various, producing great differences of quality, particularly in relation to the important particulars of texture, heat, and moisture. The openness, for example, and want of adherence in such soils, while allowing more readily the admission of heat, and of water, permit them also to be carried off

more easily and rapidly, and hence rain and sunshine do them less permanent benefit than more retentive soils. Sandy soils, thus deficient in calcareous, clayey, and loamy materials, must be ameliorated by supplying these, by means opposite to those recommended for improving clayey soils. Accordingly, it is recommended, when possible, to spread over them such portions of clay, or other adhesive materials, as may be conveniently procured. When clay cannot be had, peat may be substituted, which in some cases will be found superior to clay. But perhaps the best dressing for soils of this description will be found in strong composts of animal and vegetable manure, mixed with such earths as can be procured, particularly clay and marl. One method of improving the texture of such soils is the continued tread of animals, such as sheep, which may be folded in any part of the garden where sand prevails, and fed on turnips. Their dung will at the same time tend much to enrich the soil.

3. *Chalky Soils.*—Chalky soils abound in many parts of the British Empire, and are no less various in quality, than we have already seen to be the case with clayey and sandy soils. By subjecting them to a red heat, lime is produced, from the expulsion of their carbonic acid gas. They are found of various degrees of hardness and friability, and vary much with respect to vegetation. In our endeavors to ameliorate these kind of soils, the chief indication to be fulfilled will be to supply vegetable matter, and to improve the texture. In the thinner or light calcareous soils, clay or clayey marl, and the vegetable recrements deposited in wet or swampy situations, may be applied with benefit. On the contrary, in those which are heavier, it will tend to improve their texture, and render them more open, to spread over them a quantity of sandy loam. To these may be added composts of various vegetable and animal manure, ashes, soot, malt-dust, and the like, according to the convenience of procuring them. Soils of this nature are capable of being improved very differently, in proportion as they are more or less heavy. The light and mouldering chalky soils readily admit of the means of amelioration just pointed out; while those which are of a more heavy and solid quality, allow of them with considerable difficulty and trouble. In digging and breaking up chalky soils, great attention is requisite to the proper seasons; for if the digging be deferred till a dry season, the texture will be so bound and hard, that it will be found nearly impracticable to work them till they are softened by rain.

4. *Marly Soils.*—These soils are less common perhaps than any of the other sorts which have been already noticed. They are very similar in property, as well as in defect, to chalky soils, but are rarely so dry and sterile, as the latter are occasionally found to be. They are apt to be wet and heavy, and require in that case to be similarly treated for heavy clayey, and chalky soils. Similar attention will likewise be required, with respect to the seasons at which marly soils can be worked with the most benefit, so as to improve their texture.

5. *Basaltic and Granitic Soils.*—Basaltic soils, or such as occur in districts where basalt, or whinstone, forms the underlying rock, are generally found to be extremely fertile, on account, as it is supposed, of the carbonized materials produced during the igneous or volcanic formation of the rocks, as maintained by geologists. Granitic soils, on the other hand, or such as occur where granite or any of the rocks (except limestone,) termed primitive by geologists, are found underlying, almost uniformly exhibit sterility, owing, perhaps, to the want of carbonized materials; such rocks having been, as it is supposed, produced, not by igneous fusion, but by deposition from water. Iron generally abounds in both basaltic and granitic soils; but in the former there is fertility in spite of the iron, while in the latter there can be little doubt that it adds to the sterility. The best mode of improving granitic soils, besides that of giving abundance of manure, is to burn them, as recommended by Mr. Stafford for stiff clays; for by this means the natural effects present in basaltic soils are successfully imitated by art.

VEGETABLE SOILS.

1. *Loamy Soils.*—The variety in the colors of soils which are termed loamy, seems, in many instances, to be produced by the union or mixture of metallic substances, in greater or less proportions, and in more close, or more lax states of combination, with these; while, in other instances, it arises from earthy salts, such as sulphate of alumina. The colors arising from metallic impregnations of iron, are, for the most part, reddish approaching to brown, the color of one of the oxides of iron; while, in the case of earthy salts, they are most commonly bluish, containing, however, some of the black oxide of iron, as proved by burning, when this is converted into the red oxide, and renders the burnt soil more or less reddish, like a brick. These, however, though the most obvious causes of variety of color in loamy soils, are not the only causes; for they are much influenced in their appearances, as well as in other qualities, by the different proportions of vegetable or animal matter which they contain, and the different states of decomposition and decay to which they have been carried by length of time, cultivation, and other means. It is said, that in situations where loamy soils have been but little disturbed, and, consequently, little changed by the artificial additions of either animal or vegetable substances, and those which they naturally contained not having advanced to the stage of perfect solution and decay, they are generally found to be of a light brown color, and are termed *hazel loams.* On the other hand, where much culture has been employed for a length of time, and large applications have been frequently made of animal and vegetable matters, the natural and artificial materials of these kinds having proceeded more nearly to the state of perfect dissolution and destruction, produce a color nearly approaching to black; examples of which are common in old gardens. Peculiar loamy soils are met with near the sea-coast, or on the banks of large rivers communicating with it, and are, in general, very rich and fertile. Such soils are composed of a fine sort of sand, calcareous matter in a high state of tenuity, from the attrition or rubbing down of different kinds of shells and other marine productions; and particularly from the dissolution of various sea-weeds and innumerable marine animals, such as star-fish, which have perished and decayed there when the sea rose over that portion of the soil. All these materials have been gradually deposited, become incorporated with the earthy materials, and form a rich loamy soil. Loamy soils being in general tenacious, or more friable and mellow than clayey soils, are consequently capable of being more easily improved, with less expense, and

can also be worked at almost any season. The kinds and quantity of manure to be given must depend, in a great measure, on their natural fertility; some very rich loams requiring little, if any, as over manuring will be more apt to produce leaves and stems than flowers, while less rich loams will require occasional dressing, according to the sorts of plants cultivated.

2. *Peaty Soils.*—Soils of this description vary much in their qualities, according to the other ingredients incorporated with the peaty matter, and more particularly from the nature of the subsoil.—When the peaty matter greatly abounds, they are peculiarly barren, owing, it is probable, to the deleterious influence of the recently-discovered chemical substance, creosote—the preservative principle in peat, as it is in tar and mummy-bitumen, which prevents both animal and vegetable substances from putrefying, and which acts as a poison on both living animals and vegetables, by coagulating their albuminous juices. As creosote combines with lime, there can be little doubt that the beneficial effects which have been proved by experience to result from dressing peaty soils with lime, ought to be ascribed to this combination neutralizing the deleterious effects of the principle. Whether it may be advisable to mix quicklime with peat, in preparing composts for American and other plants, must be ascertained by careful trials. Shells, chalk, and marl, indeed, and other carbonate of lime, have often been found preferable to quicklime, on the large scale in such soils.

CASTING BRONZE STATUES.

After the artist has finished the model of the full size, he takes a mould of it in stucco; the separate pieces of this mould must be of such a size and form, as to part freely from the model.

The outside of this mould is now smoothed down, and that they may the more easily be put in their proper places again, each part has a number cut on the back of it; these are now oiled, and a cast is taken off the outside of them: this large outer case is made to part asunder in two pieces, if the figure is not very large; the numbers cut in the back of each small piece, will have made a corresponding mark on the inside of the large outer case; this enables the artist to place the parts in the outer case as he takes them from the model.

Let us suppose that the whole parts of the mould are placed in the two outer cases as they ought to be, so that if the two were put together, they would be a mould fit to cast a solid figure; but this is not what is wanted, and a mould of stucco is only fitted for casting wax or stucco figures, as it will not stand hot metal; therefore, the artist lines the two half moulds with a sheet of wax of the thickness that he wants the metal to be, taking care that the wax is pressed properly into the mould that it may have a complete impression of it; the edges of each mould are smoothed that they may fit one another.

The whole is now filled with loam to form the core, having proper vents left to convey out the gas that may arise from the heated metal acting on the core. The core is also supported by having bars of iron laid into it, bent to fit the form of the figure; the two halves are now joined, and the whole set on end; the outer case is now taken off from the mould, and each of the smaller pieces removed from the wax. Corrections are then made by the artist on this wax figure.

Long pencils of wax are attached to all the parts of the figure, from which the air will require to be taken; these are connected with the vents.

The founder now commences by coating over the whole with what he intends to be the inner surface of his mould, which is generally clay-water, and powdered charcoal; loam is applied after the first coat is dry, and increased in thickness until enough has been applied; the whole is now built round with brick, and strongly bound with screw-hoops, to prevent the mould bursting with the weight of the metal.

The whole is now dried with small fires, placed round and below it; after a short time, these fires are increased to melt out the wax, which runs into vessels placed to receive it. When the wax is all out, the fires are increased until the mould is heated to redness; it now requires to be treated the same as any other loam mould, that is, put into a pit and the sand rammed hard all round it to prevent the possibility of the metal either bursting or otherwise making its escape from the mould; the core must also be well secured in its place, to prevent it from shifting or being buoyed up by the fluid metal.

After the metal has been run into the mould and cooled, the outer materials of the mould are taken off, and the surface of the figure cleaned, the artist resumes his labour by cutting off the gates, vents, &c., making good any deficiencies by indenting, pinning, and pairing away any roughness until it is complete in all its parts.

THE INFLUENCE OF FERRO-CYANATE OF POTASH ON IODIDE OF SILVER.

Mr. R. Hunt, the author of this paper, being engaged in experiments on that variety of photographic drawing which is formed by the action of the hydriodic salts on the darkened chloride of silver, with a view to the removal of the iodide, formed by the process, from the paper, was led to observe some peculiar changes produced by the combined influences of light and the ferro-cyanate of potash. He found that the ordinary photographic paper, if allowed to darken in sunshine, and then slightly acted on by any hydriodic salt, and washed, when dry, with a solution of the ferro-cyanate of potash, became extremely sensitive to light, changing from a light brown to a full black by a moment's exposure to sunshine. Following out this result, it was discovered that perfectly pure iodide of silver was acted on with even greater rapidity, and thus it became easy to form an exquisitely sensitive photographic paper. The method recommended is the following:—Highly glazed letter paper is washed over with a solution of one dram of nitrate of silver to an ounce of distilled water; it is quickly dried, and a second time washed with the same solution. It is then, when dry, placed for a minute in a solution of one dram of the hydriodate of potash in six ounces of water; and, being placed on a smooth board, gently washed by allowing pure water to flow over it, and dried in the dark at common temperatures. Papers thus prepared may be kept for any length of time, and are at any moment rendered far more sensitive than any known photographic preparation, excepting the calotype, which it quite equals, by simply washing it over with a solution formed of one dram of the ferro-cyanate of potash to an ounce of water. These papers may be washed with the ferro-cyanate, and dried in the dark: in this dry state they are absolutely insensible, but they may at any moment be rendered sensitive by merely washing them with a little cold water. The paper is rendered quite insensible by being washed over with the above hydriodic solution, and from the photograph thus fixed, many copies may be taken. The author then described the action of the spectrum on this preparation, and pointed out that the greatest effect was produced by the least refrangible rays; but that all the rays, excepting the *extreme red*, acted with considerable energy. The impressed spectrum was, in all cases, distinctly colored from end to end; and it was found that the colors of superposed media left a corresponding tint upon the paper, but, unfortunately, as the paper dried the colors faded. These results bring nearer the probability of being enabled to produce eventually photographic pictures in their native colors. The spectra formed on these papers were all surrounded by a marked space, which was protected from the influence of the dispersed light, exhibiting another proof of the fact noticed before, by Sir John Herschel and the author, that a class of rays having peculiar negative properties emanate from the edges of the sun. Some spectra and numerous specimens of these drawings were exhibited.—*Meeting of the British Association.*

RECENT VOLTAIC COMBINATIONS.

(Continuation of Mr. De Moleyns's Paper partly inserted in our last Number.)

The author stated that from the period of the great discovery of Volta up to the period of the grand achievement of Sir Humphrey Davy in the decomposition of the alkalies, but little improvement had been effected in the development of the powers of the voltaic battery—at that period, great effects were only produced by gigantic means, which required an enormous expenditure, and therefore could only be got up by public institutions. Since the period alluded to, the battery had undergone various important improvements in the hands of Wollaston, Hare, and Faraday, which had the effect of diminishing its size and expense materially, without lessening the power. In 1828 and 1829 Becquerel, the distinguished French chemist, discovered the possibility of keeping up the energy of the combination for a long period, by the interposition of a diaphragm of sulphate of lime, or thin animal membrane, and two fluids, namely, solution of sulphate of zinc, next the zinc, and of nitrate of copper, next the copper. Previously, the power of the battery always diminished after a very few minutes, which was a serious impediment to the progress of discovery by means of electricity; it was therefore a grand step to have obtained a means of preserving the power for some hours. In our country, Professor Daniel constructed, in the year 1836, what he called the "Constant Battery," in which a diaphragm was also adopted, and two solutions of sulphuric acid and sulphate of copper. Mullins's "Sustaining Battery," in which an alkaline solution next the zinc was used instead of an acid, and nitrate or sulphate of copper in solution next the copper, (thus dispensing with acids altogether,) possessed still greater capability of preserving or sustaining the electric energy, and had been made to do so for months; but none of these combinations presented the grand desideratum of great power in small space. Grove's discovery succeeded these in 1838; but although this battery possesses great power, it had to be charged with concentrated acids, which in their subsequent decomposition produced fumes so noxious as to render it extremely dangerous if brought into general use; besides, the battery was not a sustaining one. Still Mr. Grove had made a great stride in the development of the electric force, and deserved much praise. The author then referred to his late invention of the "Calorific Sustaining Battery," by which the energies of electricity might now be applied to various useful and important purposes, for a vast power could be produced within so small a compass as to afford a certainty of the obtainment of sufficient force for locomotion, &c. The author stated, that with a series of three pairs of plates of six square inches of surface, six cubic inches of the mixed gases might be produced per minute, and electro-magnets charged in proportion; indeed, the power of the magnets, when so charged, was unequalled, and a great advantage was, that the power was obtained by extremely simple and economical means, and the battery could be made to retain its energies undiminished for any period required,—while there was a perfect freedom from noxious fumes or any other disadvantage. One cause of the immense force developed, was, that the author had obtained by his combination the sum of the affinities in place of their difference. He added, that he saw a period rapidly approaching when our views of chemical relations must undergo a great change, for it was impossible to reconcile many of the latest discoveries—including his own—with any of the theories at present in fashion in this country. It appeared quite clear to him, as it did to many continental men of science, that electricity must be looked upon as the origin of all chemical action, and not chemical action of electrical. The author concluded by stating that he was still engaged in effecting further improvements in his invention, which would, he hoped, render the instrument more generally useful.

MEDICAL RECEIPTS, &c.

Leake's Patent Pills.—Made with colocynth, sulphate of potass, and sulphate of peroxide of mercury

Lipsalve.—Put 8 ounces of good olive oil into a wide-mouthed bottle, and 2 ounces of the bloomy parts of alkanet root; stop the bottle, and set it in the heat of the sun till it be of a fine crimson color; strain the oil clear into a pipkin with 3 ounces each of fine white wax, and fresh well-cleaned mutton or lamb suet; melt the whole by a slow fire, and when taken off add 40 drops of oil of rhodium or lavender, and pour it into small pots.

White Lipsalve is made the same way by leaving out the alkanet root.

Liquid Soap.—Take 2 pounds of the best Alicant or Joppa soap, scrape it very fine, and put it into a gallon of the best spirits of wine, with half an ounce of good rosemary or lavender oil. Set the bottle in the heat of the sun for ten or twelve days, taking it in at night, and shaking it till the soap is dissolved; then filter through cotton. If properly made it will be transparent, and of the color of sack. The older the soap the better. Imitated by using common tallow soap and malt brandy, and is not so strong by half as the genuine.

Matthew's Injection for fistula, piles, &c. is a nostrum composed of tincture of cantharides diluted with water. In many cases it may produce troublesome and even dangerous irritation.

Matthew's Pills.—A nostrum composed of equal parts of black hellebore root, white hellebore root, liquorice root, turmeric, opium, purified Castile soap, and syrup of saffron, made into a mass with oil of turpentine, and divided into five-grain pills.

Magnesia Water, or *Aërated Magnesia Water*, is made by mixing 3 drams of carbonate of magnesia with 1 gallon of water, and impregnating it with ten times its volume of carbonic acid gas by means of a forcing pump, or soda water apparatus, or it may be made extemporaneously like soda water. It is a good antacid, and an excellent vehicle for antacid and lithontriptic medicines.

Marsden's Antiscorbutic Drops.—A solution of bichloride of mercury in the infusion of gentian, with a little spirit of wine to make it keep.

Marshall's Cerate.—Take 5 ounces of palm oil, 1 ounce of chloride of mercury, 2 ounces of nitrate of mercury, and ½ an ounce of acetate of lead; mix and form a cerate. It is a good stimulant for indolent ulcers.

Mineral Metallic Cement.—An amalgam of tinfoil and quicksilver combined with iron filings finely levigated, for filling decayed teeth.

Morison's Pills.—There are two sorts of these pills, No. 1, and No. 2. The first are the smallest and darkest colored, and are composed of bitartrate of potass, aloes, and assafœtdia; the second are composed of the same ingredient, with the addition of gamboge. Morison says we cannot purge too much !!!

Dr. Morrison's Pills.—A nostrum in imitation of *Morison's Pills.*

Mosley's Pills.—A nostrum composed of rhubarb and ginger, made into a mass with conserve or mucilage.

Norris's Drops.—A nostrum prepared by dissolving potassio-tartrate of antimony in rectified spirit, disguised with some vegetable coloring matter. Dr. Paris found no indications of opium.

Norton's Drops.—A nostrum composed of bichloride of mercury, disguised like the preceding.

Nouffleur's Receipt for Worms.—The following is the celebrated remedy, the receipt of which was purchased from Madame Nouffleur, by Louis XV., for a large sum of money, and published. Powder very finely, for one dose, 3 drams of the male fern, *Aspidium filix mas*, and after the patient has been prepared the previous night by an emollient clyster, and a supper of panada, this is to be taken early in the morning, fasting: two hours after a bolus is to given, made of 12 grains each of chloride of mercury and scammony, and 5 grains of gamboge. This, as Dr. Good remarks, will probably kill either the tape-worm or the patient!

Pearl Water.—Put ½ pound of the best Spanish oil soap, cut or scraped very fine, into a gallon of boiling soft water; stir the whole well, and let it stand till cold; then add a quart of rectified spirit of wine, and ½ ounce of oil of rosemary, and mix it thoroughly. It is reported excellent as a cosmetic, and for removing freckles.

Pierre Divine.—A nostrum used for tooth-ache, composed of 3 ounces of burnt alum, mixed with 1 ounce of solution of ammonia, and colored with 20 grains of vermillion.

Roche's Embrocation for Hooping-cough.—A nostrum, the basis of which is olive oil, with which is mixed, as stimulant ingredients, half the quantity of oil of amber, and of cloves.

Rousseau's Drops.—Take 12 ounces of white honey, 3 pints of hot water, dissolve the honey in the water, put the mixture in a matrass, and set it in a warm place. As soon as the fermentation begins, add 4 ounces of opium dissolved in 12 ounces of water. Ferment for a month in a warm place; then strain and filter the liquor; evaporate till there remains only 10 ounces, strain again, and add 4½ ounces of alcohol.

Rowland's Cephalæum is disguised ether.

Rowland's Kalydor is made by bruising 1 ounce of blanched bitter almonds with 5 grains of bichloride of mercury, and adding by degrees ½ pint of rose-water, triturating well, and straining through fine muslin. It is by no means a safe preparation.

Rowland's Macassar Oil is made by boiling any rancid oil with onions or garlic to take of the bad smell, and scenting with oil of roses, and coloring while warm with alkanet root.

Reynolds's Specific for Gout and Rheumatism.—This, like many other nostrums, was copied from a formula published by Want. Take 8 ounces of the fresh bulb of colchicum, 16 ounces of sherry wine; macerate for eight or ten days in a gentle heat. Color it with syrup of poppies, and add rum to flavor it. Reynolds is said to have killed himself by taking an over-dose of it.

Rymer's Cardiac Tincture.—A nostrum which is composed, according to Dr. Paris, of an infusion of capsicum, camphor, cardamom seeds, rhubarb, aloes, and castor in proof spirit, with a very small quantity of sulphuric acid.

Powell's Diuretic Drops are made with 4 ounces of oil juniper in 1 pint of spirit of wine.

Saline Draught.—A common popular prescription. Take 1 scruple of bicarbonate of potass, 15 grains of citric or tartaric acid, or ½ ounce of fresh juice, 2 drams of cinnamon water, 8 ounces of soft water, 1 dram of syrup of orange; mix as a refrigerant.

Scott's Pills.—A nostrum composed of ½ pound of extract of aloes, and 1 ounce each of gamboge and powder of jalap; make a mass of tincture of senna, and divide into four-grain pills.

Seidlitz Powders.—Take 2 drams of potassio-tartrate of soda, and 2 scruples of sesquicarbonate of soda; mix, and dissolve in ½ pint of soft water. Then dissolve 35 grains of tartaric acid in *quantum sufficiat* of water, and add this to the former solution. It must be drank in a state of effervescence. It is a mild cooling purgative; but it is not at all like the genuine Seidlitz Water.

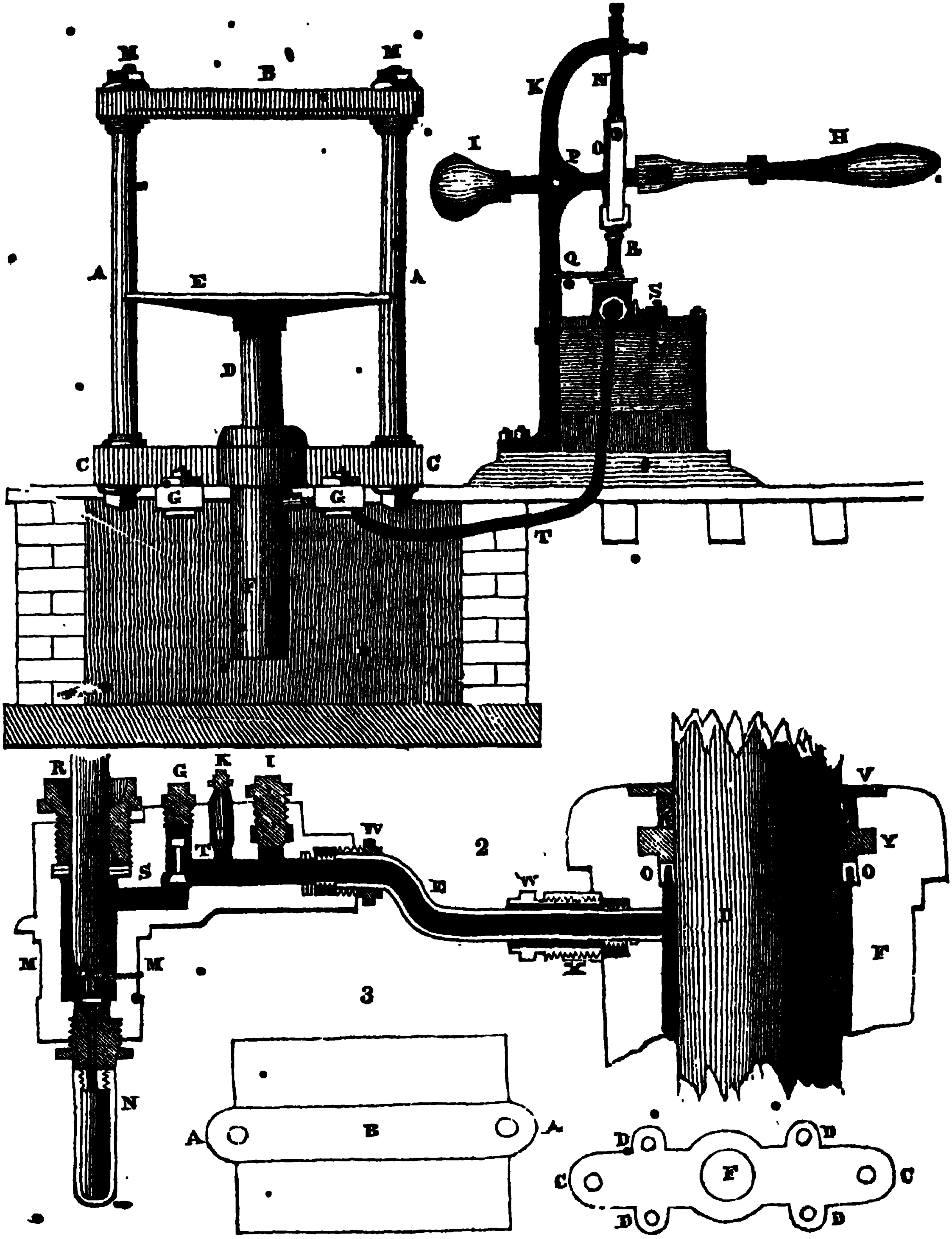
Seidlitz Water.—Take 20½ drams of water, acidulated in the usual apparatus, with thrice its volume of carbonic acid gas, about 2 drams of sulphate of magnesia, 18 grains of hydrochlorate of magnesia, dissolve, and bottle for use. If it be wanted stronger, double the quantity of the sulphate and hydrochlorate of magnesia.

Seltzer Water.—Take 20½ ounces of water impregnated by the usual apparatus with carbonic acid gas, and dissolve in it 4 grains of carbonate of soda, 2 grains of carbonate of magnesia, and 20 grains of chloride of sodium. It is a mild purgative.

Singleton's Eye Salve, or Golden Ointment, is prepared with equal quantities of orpiment (sesquisulphuret of arsenic) and prepared lard.

Speediman's Pills are composed of aloes, myrrh, and rhubarb, with the extract and volatile oil of chamomile.

Fig. 1.



BRAMAH'S HYDROSTATIC PRESS.

BRAMAH'S HYDROSTATIC PRESS.

This most valuable instrument possesses a power which no other press can approach to, much less equal. The power indeed may be considered without limit, except the positive strength and tenacity of materials; and as the whole is of solid iron, that will, in practice, scarcely form an exception. The press is represented in section in the cuts appertaining to it; where No. 1, shows the longitudinal section; and No. 2, an enlarged view of the working parts. It may be thus described, A A B, Fig. 1, is the frame, (as the view is but a section, it is to be understood that there are four supports, and that the top and bottom of the press are of sufficient width to hold the substance to be pressed), consisting of a piece of cast-iron, C C, and a top piece of cast iron, B, the two being united by the wrought-iron bolts, A, A, which must have sufficient strength to resist the whole force of the press, the pressure being produced between the under surface of B, and the upper surface of an iron table, or follower, E; F is a strong metallic cylinder, in which the rammer, or piston, D, moves. To the upper part of this piston, the iron table, E, is fixed, by the motion of which upwards, the pressure is communicated to the articles placed upon it; L represents a cistern containing water; within this cistern is fixed a small forcing, or injecting pump, of which R is the piston-rod, and H the lever by which it is worked, a contrivance being introduced for keeping the piston-rod vertical during the working: it consists of a guide, formed at the top, of the same standard, K, which supports the fulcrum, or centre pin, P, of the lever, H; the rod, N, which is part of the piston rod, slides through the socket; the part, O, of the rod is made open, to admit the lever to pass through it, a link being applied to unite the lever to the rod; I is a counterbalance for the weight of the lever. Fig. 2 is a section of the pump, on a larger scale, to show its interior structure, R representing the lower extremity of the piston rod; it is surrounded by a collar of leather, S, which is retained in its place by a tube, or perforated screw, R, which admits the passage of the piston rod, H, but which screws the two-cupped leathers with the metal ring, which is interposed between them, close down to a shoulder in the body of the injecting pump, and thus renders the junction between the injecting piston, H, and its cylinder, water-tight: the upper part of the screw, R, is excavated, to form a receptacle for oil; M M is the barrel, or chamber of the pump, in which the piston-rod does not fit; but the collar of leather, S, closely embracing the rod, will have the same effect of enlarging or diminishing the capacity of the chamber when the rod is moved up and down. In the bottom of the chamber is a suction valve. N, which allows the water to enter into the barrel from the cistern, but will not permit it to return in the same direction; it is fitted into the upper part of a tube, N, which is screwed into the lower end of the barrel: the valve itself consists of a metallic rod, at one end of which is a knob turned conical next the stem, so as accurately to fit the conical face of the hole into which it is put, the tailed is filed on one side, so that it does not entirely fill the cylindrical hole which it occupies, by which means a passage is afforded for water when the head of the valve is raised. A valve of a similar nature is placed at T, in the upper part of the pump, and being in the passage which conveys the water from the pump, and through the copper pipe, B, to the cylinder, F, it allows the water to pass from the pump to the cylinder, and prevents its returning. At K, Fig. 2, is a safety-valve, which is loaded by a steelyard and weight, as shown at K, Fig. 1: this keeps the valve shut in the ordinary course of working; but if the pressure should become so great as to endanger the bursting of the pipes, the valve rises, and the water escapes. At I is a screw plug, or valve, at which the water is discharged, when the press is to be relieved. When screwed tight, its conical end, or point, is forced into a corresponding socket, and prevents the escape of the water; but, on turning the screw back, the water is permitted to flow back into the cistern. The real situation of this discharging valve is shown in Fig. 1, at S. The cylinder, D, is surrounded by a collar of leather at O O: the leather is formed as shown in Fig. 2, being turned up to form a double cup, so that it resembles the cuff of a coat sleeve. When in its place, it is kept distended by the copper ring, P, entering the circular channel or fold, of the leather. This ring has a lodgment in a recess formed within the cylinder, F. The leather is kept down by a brass, or bell-metal, ring, Y, which is received into a recess formed round within the cylinder, as shown in Fig. 2. The interior aperture of this ring is adapted to receive the cylinder, D, and thus the leather becomes confined in a cell, with the edge of the interior fold applied to the cylinder, D, whilst the edge of the outer fold is in contact with the interior surface of the cylinder, F. In this situation the pressure of the water, acting between the folds of the leather, forces its edges into close contact with both, and makes a tight fitting round the cylinder, and as the pressure is increased, the leather is applied more closely, so as to prevent leakage under any circumstances. The metal ring, Y, is truly turned in the lathe, as well as the cavity, or cell, formed for its reception; then, to get it into its place, it is divided by a saw into five segments. Three of the lines at which it is divided, point to the centre, but the other two are parallel to each other, and the ring is put into its place (after the leather and copper rings are introduced), by putting in the four segments separately, and the one with parallel sides is put in last. The cylinder, D, is then put down in its place, and ready for action.

This plan of a divided ring was first used by Mr. Peter Kier, who, since the expiration of Mr. Bramah's patent, has made several hydrostatic presses. In the original construction, the ring, or head, of the cylinder, which kept down the leather cup, was held down in its place by several screw bolts; but as these had to bear a greater force than the whole power of the press, they were frequently torn out, or strained, so as to cause leakage. The upper part of the cylinder above the ring, Y, is filled with tow, or other soft packing, impregnated with sweet oil, which is confined by a thin plate, or ring. This packing serves at once to supply the cylinder with oil, and to prevent the admission of any substance which might injure the surface of the piston.

The pipe, B, is made of copper, and its joints are made as shown in Fig. 3. The end of the pipe has a projecting piece soldered, or screwed, upon it, and this fits into a cavity formed in the metal of the pump, or cylinder, and it is forcibly pressed into its seat by a perforated screw, V, which screws into the cavity. The joints are rendered tight by a leather ring, or washer, interposed between the end of the pipe and the bottom of the cavity in the cylinder, or pump.

The hydrostatic press is not liable to get out of order, but if any extraneous matter attaches itself to either of the valves, their action will necessarily be suspended till it be removed; for this purpose the valves can be taken out. The valve at T has a screw plug, G, fitted over it, and this regulates the ascent of the valve; or, by unscrewing the plug the valve can be taken out. To get access to the lower valve, the lower piece, N, of the pump must be unscrewed. The discharging valve, I, may also be examined by withdrawing its screw.

The operation of this press may be very readily comprehended, by supposing the pump, cylinder, and connecting pipe, B, to be filled with water, and that an adequate supply of water is contained in the cistern, L. When the handle of the lever, H, is raised, it brings up the piston, H, which would leave a vacuum beneath, if the atmosphere did not force the water through the lower, or suction valve of the pump. The lever being then pressed down, the piston-rod, by descending, diminishes the capacity of the pump; this causes the lower valve to shut, and forces the water through the valve, T, whence it passes, by the pipe, B, into the cavity of the great cylinder, F, and raises the piston, D, and pressing-table, E, together with its load, a distance proportioned to the quantity of fluid injected. On the subsequent rise of the piston of the pump, the descent of the upper valve prevents the return of the water, and consequently the fall of the cylinder, D. A repetition of the same process injects more water, and the pressure may, in this manner, be carried to a great extent. When it is proposed to relieve the action of the press, the discharge valve, I, must be opened by turning the screw back; the water then escapes out of the press into the cistern, L, and, consequently, the table, E, and the cylinder, D, descend by their own weight, restoring the engine to its original situation,

The mechanical effect of the hydrostatic press will admit of an easy calculation; for it is known, that if there be a mutual communication between two columns of any fluid, whatever pressure or effort may be exerted on the one, will be transmitted to the other in a ratio proportional to the respective area of each column, consequently the proportion of the area of the injecting pump to that of the cylinder, constitutes the hydrostatic power of the press, and the mechanical effort exerted on the injecting pump is transmitted to the cylinder, D, by the intervention of the fluid, in a ratio proportional to their comparative areas. If the diameter of the piston, H, be one quarter of an inch, and that of D one inch, that is to say, four quarters of an inch, one pound lodged upon the piston rod, G, will be in equilibrio with sixteen pounds lodged upon the table, E, the weights of the parts of the engine attached to, and moving with each piston, being respectively included. And if the length of the lever, P H, be fifteen inches, and the distance between the centres of motion, P O, of their action upon the piston rod two inches, one pound at the end of H will gain an advantage of 7½ times, when compared with that at N. Instead, therefore, of sixteen pounds, upon the table, G, being equal in effect to counterpoise this last action, there will be required upwards of 120 pounds. But a man in this action of pumping, by a downward pressure, can, without difficulty, apply his whole weight, and with great ease one-third, or one-fourth, of his weight, suppose fifty pounds. In this case the pressure will be equivalent to fifty times 120 pounds, or 6000 pounds; that is to say, nearly three tons.

To compare this engine with a screw in theory, it is necessary to inquire what fineness of thread, and length of lever, would afford a purchase of 120 to one. Suppose the thread of a screw, substituted in the place of the cylinder, D, to be one-tenth of an inch thick, the distance from the top of one thread to the top of the next, will, in this case, be one-fifth of an inch. This is the space through which the weight must rise in one revolution of the screw; the power must, therefore, move through 120 times that space, namely, twenty-four inches. A lever, or radius, four inches long, will describe a circle somewhat larger than this, and, consequently, such an engine would, in theory, be equal in power to the hydrostatic engine we have been describing.

But when the subject is viewed practically, the difference between the two machines appears to be very remarkable. All practical men know how very large a part of the force, operating by means of engines, is employed in overcoming friction. Every one is aware of the extreme friction between solids, and the very slight friction which takes place between the parts of fluids. This is seen in the common expedient of oiling the pivots of wheels, and in the very gradual decay of motion in fluid bodies, while solids moving upon each other stop at once as soon as the force is diminished to a certain degree. The screw is an organ peculiarly liable to friction, and this friction is always much greater than the whole of the re-acting force, for there are few instances where a screw will return from extreme pressure, when the agency upon the lever is withdrawn. It is also to be considered, that the whole force of the weight, or resistance, acts directly upon the face of the thread of the screw, at the place where the motion is required to take place. It has not been ascertained in what degree this resistance, or friction, increases with the weight. In lighter actions, the simple ratio has been inferred, but under more severe pressures, the two metallic faces exclude the greater part of the half fluid matter between them, and appear, by the magnitude of their resistance, to be attached to each other by a process of the nature of cohesive attraction.

METEORIC IRON.

In the room which occupies the north-eastern angle of the British Museum, one of those lately opened, is placed that large mass of meteoric iron which was given to the Museum by Mr. Woodbine Parish; it is part of the gigantic one which was found, and still remains in the plain of Otumba, in the district of Buenos Ayres, in South America; the weight of this portion of it only is 1,400lb.; it is the finest specimen of the kind in Europe. Various theories have been advanced to account for the formation of these substances; the hypothesis which supposed that meteoric formations, of which there are many specimens in this apartment, had their origin in our own planet, is now found untenable, and has been abandoned. The appearances of a thunder-storm and of a fire-ball have been ascertained to differ in various important respects, and it is vain to allege that they are formed on the ground by the action of common lightning; that they have been thrown up from the volcanoes is equally difficult to conceive; the ashes which are ejected during the eruptions of Vesuvius and Etna have, by reason of their lightness, been driven to a considerable height, but there is no power in nature that is known which possesses a sufficiency of projectile force to propel solid masses many hundred miles through so dense a medium as the atmosphere. It appears, therefore, likely that these phenomena derive their formation from other regions than ours. The hypothesis which has supposed them to be generated in our atmosphere is not attended with less difficulty; there are scarce any two persons who have supposed the atmospherical formation of the meteorolite, that have agreed as to the manner of their formation. Laplace suggested the probability that they might be thrown out from the volcanoes of the moon; nor is it unlikely, as volcanoes have been discovered in that planet, and a projectile force equal in power to that possessed by ours would be sufficient to propel fragments that might possibly reach the surface of the earth, the more especially, as no atmospherical resistance would be encountered, the moon being known to possess none. It is demonstrated by calculation, that if a body ponderate be projected from the surface of the earth with sufficient force to give it a certain velocity, it will never return; seven miles a minute is sufficient to accomplish this. From the moon the required velocity to produce such an effect is about four times as much as a cannon-ball, so that though the probability may be against it, the supposition is far from impossible. It is, however, more likely that they are the fragments of comets, because those bodies, from their numbers, make the question of mere probability favourable to such hypothesis, as also, that from their nature they are subject to violent chemical changes, and from the comparative smallness of their dimensions a fragment thrown from them with any slight velocity would never return from the mass to which it originally belonged, but would traverse the celestial regions till it encountered some planetary or other body sufficiently ponderous to attract itself. All the masses of native iron which have been found in South America, and also in Siberia, have been ascertained by Howard, Klaproth, and Chladni, the Russian, who wrote an account of the Siberian mass of iron, to contain nickel, and exactly resemble the iron found in the stones which have fallen from the atmosphere; there is not a doubt but they have the same origin, the more so, as it has been shown by the above celebrated men, that real native iron is distinguished from that of meteoric origin by the absence of nickel.

CALICO PRINTING BY ELECTRICITY.

SCARCELY a week elapses without witnessing some extraordinary discovery in electricity; the following is one which at present promises to be of considerable value, if the time required to perform the process be not longer than the purposes of manufacture will allow,—an entirely new application of the science is now proposed. This is nothing less than the pattern printing in innumerable colors, of calicoes and other piece goods, by the sole agency of the galvanic fluid, for which letters patent have already been granted to the inventor. The process may be thus briefly described:—Both in the old and new plans, the goods are previously immersed in a chemical solution, called a mordant (of which there are three separate kinds), and which prepares the cloth for the reception of the colors. This done, the part to receive the impression of the pattern, is extended over a flat surface of platinum, to which the negative pole of a battery is attached. Upon the cloth thus arranged is placed the metallic pattern, formed for instance of a piece of copper, a piece of silver and a piece of iron, the three arranged in the shape of a flower, and fastened together by convenient means. A stream of voltaic electricity is then conducted to this metallic pattern, with which the positive pole of the battery has been previously attached, the cloth while the mordant is wet, acting as a conductor. Metals form an oxyde or some other compound, by the agency of voltaic electricity; in consequence of which certain colors, dependant on the mordant, are impressed on the cloth. In the instance we have named, the copper representing a leaf, would give out a *green* color, the stem of silver a *brown*, and the iron a *blue*. By this process we are given to understand, that the most minute patterns may be printed with a degree of accuracy otherwise unattainable, and that every description of piece goods may thus be printed with facility and success.

PREPARATION OF THE GASES

THE preparation of coal gas, of oxygen, hydrogen, chlorine, and nitrous oxyde having been given in former parts of this Magazine, the other gases only will be treated of.

To procure Nitrogen Gas.—Wash a piece of beef well, and cut it into very small bits; put these into a tubulated retort and place them over a lamp. Now pour in some diluted nitric acid, and insert the beak under a receiver standing on the shelf of a pneumatic trough. Nitrogen gas will come over, and fill the glass or glasses. Nitrogen gas is somewhat lighter than atmospheric air, of which it forms about three-fourths. It exists abundantly in nature, is the peculiar and almost characteristic ingredient of animal matter, the basis of the nitric acid, and one of the constituents of ammonia; it is capable of indefinite condensation and expansion, like atmospheric air.

Iodine Vapour.—Put a small quantity of iodine into a retort, and hold it over a lamp: when heated considerably (about 300°) a very beautiful vapour or gas will come over, which may be received in jars on the pneumatic shelf, over water.

Carbonic Acid Gas.—Into a glass tumbler put half an ounce of powdered chalk, and add to it a drachm of sulphuric acid. Very little agitation will take place owing to the want of power which the acid has to diffuse itself among the particles of chalk. But if the tumbler be one-third filled with water, the acid will hastily combine with it, and thus becoming diluted, will present so large a surface to the chalk, as to attack it at all points, seizing the lime, and driving off the carbonic acid with great effervescence. By holding the nose over the tumbler, the peculiar odour of the carbonic acid may be perceived. When the effervescence is at an end, a white powder will subside at the bottom of the tumbler, which is sulphate of lime.

Ditto by Combustion.—Immerse a piece of ignited charcoal in a jar of oxygen gas. A very beautiful and rapid combustion will immediately take place. The charcoal will at last be consumed, and of course the combustion will cease. On inspection, the glass will be found filled with carbonic acid gas. This gas will be absorbed by quick lime, or by lime water (which it will render turbid) placed at the bottom of the jar; from this combination it may afterwards be expelled by diluted sulphuric acid. That carbonic acid has been formed, may also be proved by the extinction of a candle, or taper flame.

Nitrous Gas.—This gas may be procured by putting half an ounce of mercury or copper filings into a tubulated retort, and pouring over them an ounce of diluted nitrous acid. In combining with the metal, a considerable quantity of gas will be evolved, which may be received in a jar over water or mercury.

Muriatic, or Hydro-Chloric Gas.—Put an ounce of muriate of soda into a tubulated retort above a lamp, and pour an ounce of diluted sulphuric acid over it: the soda leaves the muriatic acid (which will fly off in a gaseous form) and attaches itself to the sulphuric acid, forming sulphate of soda. The gas may be received in a jar, over mercury.

Euchlorine, or Protoxide of Chlorine.—Pour one ounce of muriatic acid, diluted with an ounce of distilled water, over one ounce of chlorate of potass in a retort placed over a lamp, the heat of which is rather gentle. Receive the gas which ascends, over mercury. This gas has a yellowish green appearance.

Sulphurous Acid Gas.—Pour two ounces of sulphuric acid over an ounce of copper filings in a glass retort, and place the retort on a ring over a lamp: when ebullition (that is, the action of the acid on the metal) commences, plunge the beak under a bell-glass standing in a mercurial pneumatic trough. A gas, which is the sulphurous acid, will ascend, and displacing the mercury, will fill the glass.

Ammoniacal Gas.—This gas is generally produced from animal matters, and by its readiness to combine with carbonic acid, we are enabled to possess it in a tangible, or concrete form, as carbonate of ammonia. The following methods of preparing ammoniacal gas, synthetically, will be found amusing and satisfactory, insomuch as they thus prove the composition of this gas, which by analysis had before been accounted a compound of nitrogen and hydrogen: put some granulated tin into a teacup, and pour over it a little strong nitric acid, so as to do little more than to moisten it. The metal will be acted on by the acid, and red fumes of nitrous gas will arise: when this action has ceased, pour into the cup a little of the solution of pure potass. A very pungent vapour or gas will now arise, which from its odour may be known to be ammonia. Here we must be assured that the ammonia is synthetically produced by the decomposition of the substances employed; for we are aware that ammonia itself did not enter into the composition. Ammonia being composed of nitrogen and hydrogen, we must account for its formation by the evolution of these gases in such proportion as to form it. In the first instance, however, the ammonia is not perceptible by its odour, because at the instant of its formation, it is attacked by some of the nitric acid, and thus nitrate of ammonia is combined with oxide, or nitrate of tin. The addition of solution of potass, however, by combining with the nitric acid, liberates the ammonia from its dormant state, and consequently its odour is exhaled.

Sulphuretted Hydrogen Gas.—Put one ounce of sulphuret of iron into a tubulated retort, and pour over it an ounce of diluted sulphuric acid. The sulphuric acid, in attacking the iron, will receive the assistance of the oxygen of the water (by which it was diluted) in oxidising the metal before it is converted into sulphate of iron. The hydrogen of the water will thus be free to combine with the sulphur. The sulphuretted hydrogen may be received in the common way in a pneumatic apparatus, or in a bladder attached to the beak of a retort. The following is M. Gay Lussac's method of preparing sulphuretted hydrogen gas:—"The way I obtain this gas is, to mix two pints of iron filings with one of flowers of sulphur, then to put it into a mattras with as much water as will give it the consistence of soap, and heat the vessel, to promote the union of the sulphur and iron, which soon shows itself by a great disengagement of heat, and a black color spreading through the whole mass. Then, sulphuric acid diluted with four times its volume of water, disengages the sulphuretted hydrogen with nearly as much rapidity as from an alkaline hydro-sulphuret. The mixture should never be prepared before the gas is to be obtained."

Hydro-zincic Gas.—Pour diluted sulphuric acid over some broken zinc in a retort; place the beak under a pneumatic shelf, and receive the gas which comes over, in jars. Here the sulphuric acid, in its action upon the zinc, receives the aid of the oxygen of the water, by which the metal is oxidised previous to its solution. The hydrogen in consequence is set free; but before it leaves the retort, it combines with a portion of the zinc in very minute particles; by which means it is converted into hydro-zincic gas.

Arseniated Hydrogen Gas.—Put 4 drams of zinc filings into a small retort with 2 drams of filings of arsenic; and pour over them 1 ounce of diluted sulphuric acid: if the beak be put under a bell-glass on the pneumatic shelf, arseniated hydrogen gas will ascend and displace the water. Here the acid, in acting upon the zinc, decomposes the water used as a diluent; the oxygen of which oxidises the metal, whilst the hydrogen is set free to unite with the arsenic. This gas burns with a very delicate bright flame.

Phosphuretted Hydrogen Gas.—Put into a small retort half a dram of phosphorus in small pieces, and a dram of zinc filings. Pour over these, 3 drams of sulphuric acid diluted with 6 drams of water. Put the beak of the retort under a bell-glass in a pneumatic trough: phosphuretted hydrogen gas ascending will displace the water, and fill the glass. Several glasses may be filled from this quantity: one of these glasses should have a stop-cock, by which bladders may be filled, or by which it may be allowed to issue for combustion in atmospheric air. In this experiment, the zinc and acid decompose the water, whose hydrogen being set free, combines with the phosphorus, and both are evolved in the gaseous form. The preparation of this gas may be varied by putting 5 grains of phosphorus, cut small, and 10 grains of zinc filings into a wine-glass, and by pouring over them half a dram of sulphuric acid diluted by a dram of water. Globules of phosphuretted hydrogen gas will ascend to the surface, and will inflame as soon as they come in contact with the air. This experiment may be varied by holding the beak of the retort in a perpendicular position, and allowing the gas to ascend and combine with the atmospheric air. In doing this, a continued stream of fire will be seen to issue from the liquid below. This is an interesting experiment. To prevent inconvenience, the retort may be placed in a basin, in an upright position, and the ingredients may thus be poured in without inconvenience. A still further variation in the mode of combination between phosphorus and hydrogen, is as follows:—Prepare a jar of hydrogen gas over mercury, by the decomposition of water by sulphuric acid and iron filings. Pass two or three small bits of phosphorus up through the mercury, that they may remain in contact with the hydrogen gas. In the course of ten or twelve hours the combination will be complete.

Silicated Fluoric Gas.—Pulverise an ounce of fluate of lime (fluor spar), and half an ounce of glass; put these into an earthern or glass retort, and pour over them an ounce of sulphuric acid: receive the gas in glass jars over mercury.—water absorbs so much of this gas, that it can hardly be collected over it. This gas being already saturated with silex from the powdered glass, has no action on any glass vessels which may receive it, so that it may be kept in them for any length of time.

Fluo-boric Gas.—Put into a tubulated retort 4 drams of pulverised fluate of lime, 2 drams of dry boracic acid, and 3 ounces of sulphuric acid; give them a tolerable heat; the gas which comes over will be the fluo-boric, which does not act upon glass, and may be condensed (as it is remarkably absorbable by water) in the receiver, containing a few ounces of water at the bottom, and surrounded by pounded ice, or a freezing mixture: if the water has absorbed sufficient, the whole will be of an oily consistence like sulphuric acid. It may be preserved in a stoppered bottle. In the formation of this substance, the sulphuric acid separates the lime from its combination, forming sulphate of lime; the two acids accordingly combine together, and are driven off by the heat in a state of gas.

GELATINOUS SUBSTANCES AS FOOD.

The commission nominated by the Academy of Science to examine the properties of gelatinous substances as food have made their report. Their exclusive attention to the subject, and the numerous experiments they have made, warrant them in arriving at the following conclusions:—

First.—It is impossible by any known process to extract from bones an alimentary substance, which either alone or mixed with any other substance can be a substitute for meat.

Secondly.—Gelatine, albumen, fibrin, taken separately, nourish animals only for a short time, and very insufficiently. These substances, when unmixed, soon excite insurmountable disgust, and to such a degree, that animals would rather die than touch them.

Thirdly.—These same principles, united artificially, are taken with less repugnance, and for a greater length of time than when they are separate; but their power of nutrition is not greater; for the animals that eat them even in considerable quantities ultimately die with every appearance of complete inanition.

Fourthly.—The muscular flesh in which the gelatine, albumen, and fibrin are organically combined with other substances, such as fat, salts, &c., even in very small quantities, is sufficient for complete and prolonged nutrition.

Fifthly.—Bones are equally nutritious, but the quantity consumed in four-and-twenty hours ought to be considerably more than of meat.

Sixthly.—All kind of preparation, such as decoction in water, the action of chlorohydric acid, and particularly the conversion into gelatinous substances, diminishes the nutritious qualities of bones, and even in some cases removes them altogether.

Seventhly.—Nevertheless, the commissioners have been reluctant to pronounce, without further investigation, what may be the effect of the use of gelatinous substances mixed with other aliments, when applied to the nourishment of man. They believe that direct experiments alone can throw any degree of certainty on this subject. They are at present actively engaged in them.

Eightly.—Gluten of itself affords complete and prolonged nutrition.

Ninthly.—Fat substances taken as the only food support life for some time; but they produce only very imperfect and disordered nutrition, the fat accumulating in all the animal tissues, sometimes in a state of oleine and of stearine, sometimes in a state of almost pure stearine.

ON THE PROBABLE NUMBER OF SPECIES OF INSECTS IN THE CREATION.*

BY J. O. WESTWOOD, ESQ.

Our great and pious naturalist, John Ray, ("le premier véritable naturaliste pour le règne animal," as the equally great Cuvier has styled him,) in his "Wisdom of God in the Works of the Creation," published at the close of the seventeenth century, tells us, respecting the number of British insects;—"The butterflies and beetles are such numerous tribes, that, I believe, in our own native country alone, the species of each kind may amount to 150 or more. The fly kind, (if under that name we comprehend all the flying insects, as well such as have four, as such as have but two wings, of both which kinds there are many subordinate genera,) will be found in multitude of species to equal, if not exceed, both the fore-mentioned kinds. The creeping insects that never come to be winged, though for number they may fall short of the flying or winged, yet are they also very numerous; as by running over the several kinds, I could easily demonstrate. Supposing, then, there be a thousand several sorts of insects in this island and the sea near it, if the same proportion holds between the insects native of England and those of the rest of the world, as doth between plants domestic and exotic, (that is, as I guess, near decuple,) the species of insects in the whole earth, land and water, will amount to 10,000; and I do believe they rather exceed than fall short of this sum." Subsequently, however, in consequence of having discovered a greater number of English moths and butterflies, he was induced to consider that the total number of British insects might be about 2,000; and those of the whole earth 20,000.

Linnæus, in the 1761 edition of the "Fauna Suecicæ," described 1,700 species of insects, inhabitants of Sweden:† and, in the 12th edition of the "Systema Naturæ," the whole number of these animals, (Swedish and exotic,) with which he had become acquainted, amounted to about 3,000.

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* It must be borne in mind, that the following observations do not apply to the number of individuals, but to the different kinds or species of insects. Those who have observed "a swarm of gnats at eventide," (which, in general, consists of myriads of individuals of the same species,) will at once perceive how impracticable it would be to attempt to decide the former question. The numerical variation, however, which exists in the different species of insects, opens very interesting views of nature, and is a question well worthy of the attention of the entomologist.

† This was in his day considered so remarkable a fact, as to induce Reaumur to assert that Sweden was richer in the number of its insects than any other country in the world.

Let us now look at the state of the science of entomology in the present day. Mr. Stephens has given us a Catalogue of named British insects, amounting to 10,000; and, since the time of its publication, numerous additions have been made to the list. It was a curious coincidence, that our poet of nature, Thomson, should have hit upon this very number, in order to give some idea of the vast profusion of summer insects: and Mr. Stephens has happily adopted the lines printed below in italics as his motto:—

> "By myriads, forth at once,
> Swarming they pour; of all the varied hues
> Their beauty-beaming parent can disclose.
> Ten thousand forms! *ten thousand different tribes*
> *People the blaze.*"

Mr. MacLeay, whose general knowledge of the extent of modern collections cannot be questioned, stated, in the second part of his "Horæ Entomologicæ," published in 1821, that there were certainly more than 100,000 of the annulose animals (nearly synonymous with the Linnæan insects) preserved in the various collections.

Messrs. Kirby and Spence, adopting a conjecture of Decandolle, that the number of species of plants may be somewhere between 110,000 and 120,000, observe, that, "as a vast number of phanerogamous plants and fungi are inhabited by several species (of insects), we may form some idea how immense must be the number of existing insects; and how beggarly does Ray's conjecture of 20,000 species, which in his time was reckoned a magnificent idea, appear in comparison!" After instituting a comparison between the numbers of British insects with that of British phanerogamous plants, whereby it appears that, on the average, there are more than six insects to each plant; these authors arrive at the conclusion, that, "if we reckon the phanerogamous vegetables of the globe, in round numbers, at 100,000 species, the number of insects would amount to 600,000." If we say 400,000, we shall, perhaps, not be very wide of the truth.

With respect to the relative proportion of the different orders to each other, Messrs. Kirby and Spence state, that the Coleoptera may be considered as forming at least one to two of our entire insect population. Now, however, that the same attention is bestowed upon the minuter Hymenoptera, Diptera, and Lepidoptera, as has been long given to the small Coleoptera, we find this calculation gives too great a share to the beetles. In Mr. Stephens's Catalogue, they barely reach one third of our native insects. If, therefore, we take the group of predaceous beetles (being the one which has been most recently investigated in the detail of its species with all possible advantages and assiduity by Dejean), we find that, although it did not bear, in the "Systema Naturæ," a greater proportion to the whole order of beetles than one to sixteen, yet not only in Stephens's Catalogue of the English species, but also in the general Catalogue of Dejean, the proportion which it bears to the whole Coleoptera is about one to sixteen. And, as I have already stated that the number of species described by Dejean may be averaged at 2,000, the whole number of beetles, at the above rate, would not exceed 16,000; and, by adding 4,000 more for other known species, the number would not exceed 20,000: and yet Count Mannerheim, in his recent monograph upon the Staphylinidæ, states that Dejean had informed him, in 1830, that he then possessed nearly 18,000 Coleoptera; and the baron himself informed me, two years ago, that he possessed between 20,000 and 21,000 Coleoptera. And by estimating the beetles, as above, at one to three of the insect tribes, we shall only obtain 60,000. What a wide field, therefore, remains to be investigated, before we shall become acquainted with the 600,000 or even 400,000 species supposed by Messrs. Kirby and Spence to exist; and how absurd does it seem to consider our systems, or rather system, as firmly established, whilst so little is comparatively known!

THE COCHINEAL INSECT.

It is now nearly fifty years since this valuable commodity was conveyed into our East Indian territories, by an enterprising individual, an officer in the Madras army. Thirty years ago the Spaniards regarded this insect as being invaluable to them, producing a revenue to Spain larger than that afforded by their gold mines, although they were both derived from the self-same source—the state of Mexico. It was the desire of the Hon. East India Company to introduce the cochineal into their territories at the above period, and large rewards were held out to speculating adventurers to tempt and encourage them to colonize the insect on their various estates. But they could not succeed in their new undertaking. It has now, and particularly within the last two or three years, spread itself over the face of the whole of the Indian peninsula that falls within forty-two degrees of north latitude, and has destroyed almost every cactus shrub (the prickly pear) upon which plant it wholly subsists. It may be deemed somewhat remarkable, when the great value of the cochineal insect is considered, that the natives have never encouraged it as a feature of commerce. Certain European adventurers have, however, within the last five years, endeavoured to turn the insect to a good account; but they have all of them signally failed in producing cured samples of any size, so as to wear a favorable complexion in the London market, when placed in juxta-position with the "grana fina" of Mexico and Oaxaca, and as none of the parties had had an opportunity of witnessing the mode in which the "nopaleries" in South America were managed, they were quite at a loss how to treat the insect. Some conjectured that the fly was a wild species of the "coccus coccinelifer;" whilst others considered it was the wrong plant upon which it was reared in India; and on the other hand, it was decided that the climate was uncongenial to the prosperity of the insect, which, although it proved highly prolific, yet never arrived at any size. The Indian cochineal yields a stronger dye than that of New Spain, and is in every way calculated to prove a truly valuable article of commerce, if it could be brought to a size equal to that of the insect of New Spain. A gentleman living on the Coromandel coast, a short time since, fed a small colony of these insects upon the "cactus inermis," a species of the "cactus opuntia," perfectly free from thorns, and which it is said the South American coccus exclusively feeds upon, but it quickly perished under the bite of the insect, although the animalculæ were not usually numerous; and he was led to imagine that the large "acicular" thorns which protrude from the lobes of the prickly pear (for the leaves are truly lobate) would, if carefully removed, tend considerably to promote the size of the insect in its growth. He also, among several other experiments he adopted in his treatment of the cochineal, rescinded a portion of the exuberant foliage of the plant, and diminished the quantity of the larvæ on the leaves, so as to afford the shrub a more favorable opportunity of struggling against the innovations of the insect incubus. In this latter experiment he proved successful; and he observed, as the vigour of the plant was protected, in a corresponding ratio did the cocci increase in size, nor were they enveloped so thickly in flocculent matter as those which were allowed to thrive unattended to and neglected. Cochineal is at this time selling at the public sales in Calcutta for eleven and twelve rupees per seer of two pounds avoirdupois, which is at the rate of 12*s.* per pound; and yet, strange to say it, the insect abounds throughout India, and with a little pains and attention bestowed upon it, might be converted into a valuable article of commerce, and would, there can be but little doubt, in time expel the presence of the Spanish insect from the market.

MEMORANDA.

Experiments made by Messrs. Charles Green and Rush, during three Experimental Balloon Ascents.—On speaking of various atmospheric currents, Mr. Green says, in reference to a constant current at a great elevation, "It is my firm opinion, that in England, at a great elevation, the north-west current will, in general, be found to prevail throughout the year, without reference to the direction of the wind near the earth." This current, according to Mr. Green, varies in its elevation, from 3,000 to 14,000 feet. Mr. Green describes this upper current as carrying his balloon at the rate of six miles per hour, when the lower current will carry him at the rate of thirty miles per hour. Mr. Green described, that in one of his *ascents* from Liverpool, he entered the constant current from the north-west, at an elevation of 14,000 feet, and in his *descent* he entered the lower or south-east current, at an elevation of 12,000 feet. By the upper or constant north-west current, he describes himself as travelling at the rate of six miles per hour, and by the lower or south-east current, at the rate of eighty miles per hour. Mr. Green stated the great pleasure he felt on witnessing the formation of snow, hail, and rain, at various elevations. On speaking of the velocity of balloon travelling Mr. Green, says, "The greatest speed I ever travelled with the balloon was 97 miles in 58 minutes;" but he has often travelled at the rate of between 60 and 80 miles per hour.—*Meteor. Soc. Lond.*

Railway Traffic.—The following are the receipts of the principal railways in operation for one of the weeks of last month, that is to say, up to the dates to which the respective returns are made: Brighton, 1,756*l.*; Blackwall, 1,077*l.*; Hull and Selby, 891*l.*; York and North Midland, 1,765*l.*; North Midland, 4,658*l.*; Midland Counties, 2,923*l.*; Birmingham and Gloucester, 2,245*l.*; South Western, 7,691*l.*; Birmingham and Derby, 1,327*l.*; Great Western, 14,934*l.*; Northern and Eastern, 859*l.*; Birmingham, 18,596*l.*; Eastern Counties, 942*l.*; and Great North of England, 1,457*l.*

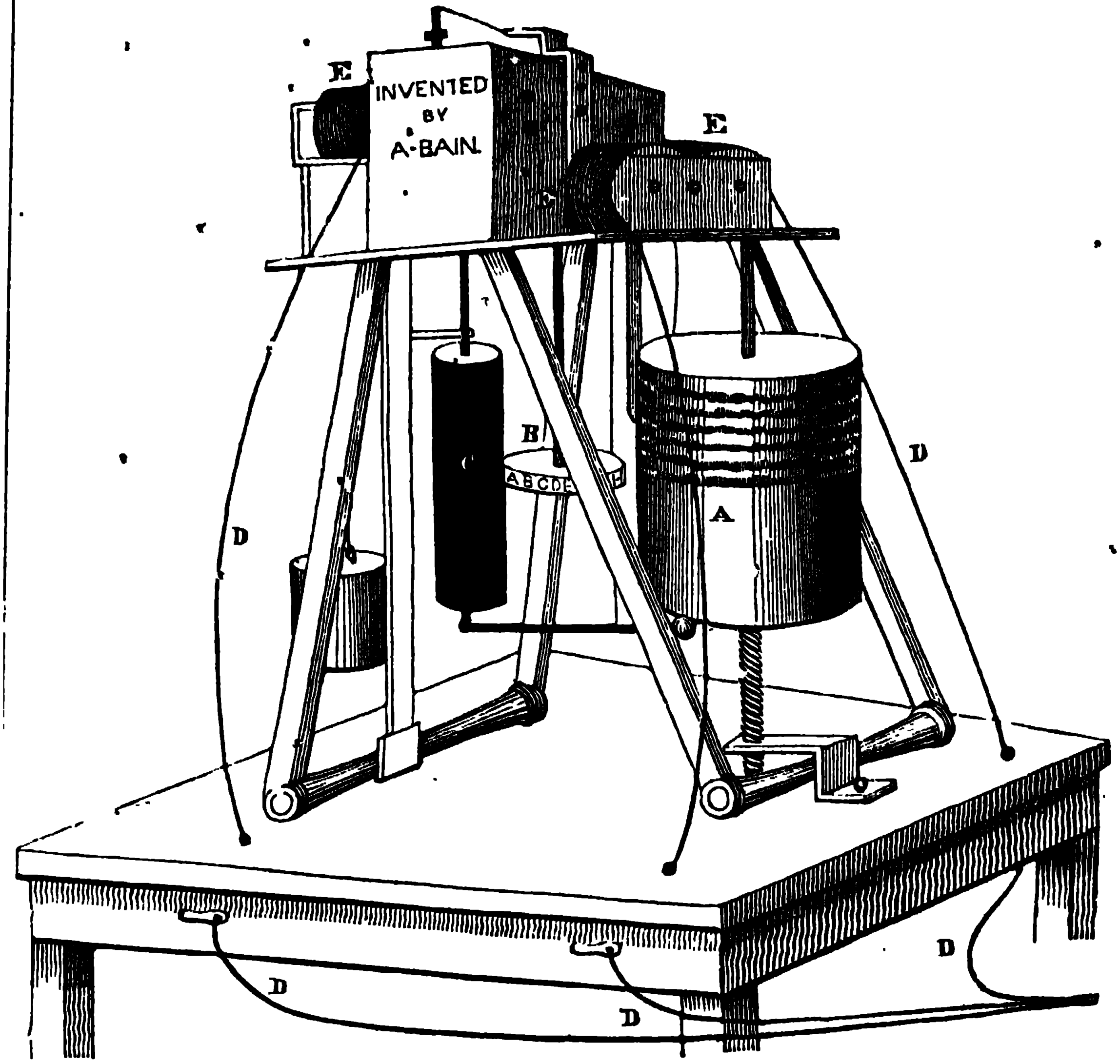
Grass Lawns.—The best and cheapest way to treat grass lawns or banks that are subject to crack in dry weather, is to fill up the cracks with any light sandy soil when they are most open in dry weather, and afterwards to roll the ground, when sufficiently soft just to allow the roller to make an impression upon it, but not when it is very soft, for if so, it will cause it to crack worse when it again becomes very dry. Persevere in filling up the cracks; if they are large sow a few grass seeds upon the fresh soil, it will then soon become firm, and crack but little after the first year.—*Gardener's Chronicle.*

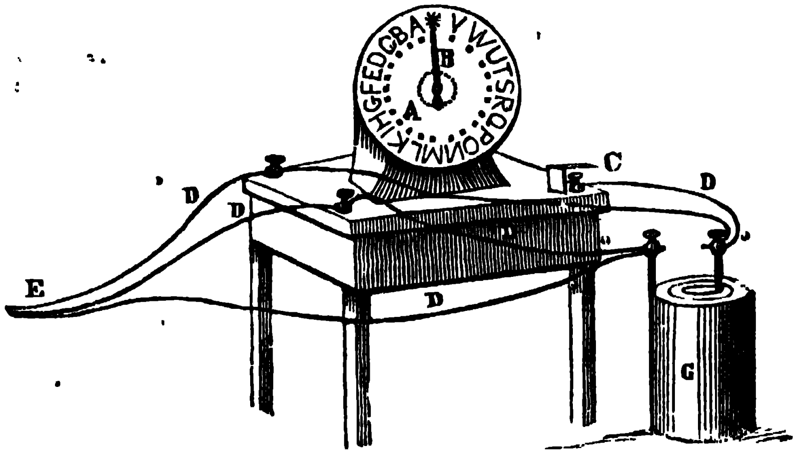
Recovery from Drowning.—Little or no water is found in the stomach of a drowned person; and when it is present, it can in no way have contributed to death. The experiments of Orfila and Marc have proved that water is never found in bodies submersed after death; and that it cannot be made to enter the stomach without the assistance of a tube passed into the gullet. This fact, and that of little or no water entering the lungs, cannot be too widely propagated, as the popular prejudice is in favor of the opposite opinion; and bodies taken out of the water are still rolled on barrels, and held up by the heels in order to dislodge it; a practice fraught with the greatest danger, if the smallest chance of resuscitation exist.—*Dr. A. Thomson.*

Preservation of Meat.—The new process for preserving meat by injecting salt into it by means of powerful pneumatic pressure, will shortly be put into operation at Buenos Ayres and other parts of South America, where it is well known that cattle are extensively slaughtered for the exportation of their hides, the carcasses being completely valueless. The meat thus prepared will form an original article of export to this and other countries, and, should the speculation succeed, our provision markets may be supplied with a new description of animal food at a very cheap rate. So extensive are the herds of cattle and sheep in the immense and productive regions of the Pampas, that a traveller in South America a few years since states, that the carcasses of sheep were used as fuel in heating furnaces.—*Times.*

Bituminous Shale.—A new branch of industry seems likely to organize itself in Belgium. The different produce extracted from bituminous shale. by means of the works established about ten months since on the banks of the canal, near Lacken, merits the attention of consumers, especially the extracts of oil and charcoal. This last production, of which extensive application has been already made in the sugar-refineries, and particularly in that of M. de Vandenberghe de Binkum, at Tirlemont, may acquire great importance at a moment when the depreciation of sugar cannot be balanced but by a diminution of price upon the original materials of manufacture. A reduction of thirty per cent. on the price of charcoal, fit for refining, would offer an important advantage, and it is to be hoped, that the experiment may prevail over the prejudices of those, who from habit, stop short on the road of improvement. The works of M. de Binkum are open to all manufacturers, who wish to assure themselves, by personal inspection, of the advantages that the employment of this kind of charcoal offers. The shale charcoal possesses, moreover, a disinfecting power, which acts instantaneously on all the animal matters, even the most fetid, and transforms them into a powerful manure. These two applications of this preparation alone would suffice to assign an important place to this new branch of industry.—*Le Fanal.*

Fig. 1.





BAIN'S ELECTRO-MAGNETIC PRINTING TELEGRAPH.

BAIN'S ELECTRO-MAGNETIC PRINTING TELEGRAPH.

An exhibition of a most ingenious machine is going on daily at the Royal Polytechnic Institution, the construction of which has excited the wonder of the public and the admiration of the scientific world. The instrument is called the "Electro-Magnetic Printing Telegraph;" the inventor is Mr. Alexander Bain, previously known as the contriver of the electrical clocks; and the object contemplated by him is the faultless and instantaneous transmission of telegraphic information, in a printed form, between a central and any number of radiating points. This invention is so remarkable an application of the powers of electro-magnetism to the ordinary purposes of life, that we deem it worthy the profound attention of every civilised government, as well as of railroad proprietaries and other similar associations; and on this ground we invite general attention to the details we are about to give of its phenomena and practical working.

We have so often described the properties of an electro-magnet that we almost feel inclined to apologise for here re-introducing an explanation of its peculiar power; but as many new readers will probably peruse this communication who do not understand exactly what it is—and who, in ignorance of its nature, cannot possibly arrive at any comprehension of our succeeding remarks—we observe (for their enlightenment), that an electro-magnet is only a magnet during the period a current of electricity is passing through the wires attached to it; and that when such current ceases, it is deprived of all magnetic power whatever. This peculiarity (never yet satisfactorily explained) enables an operater to establish and to break a magnetic influence at pleasure, and thus to create motion in wheels, pendulums, springs, &c., by the agency of electricity alone.

Mr. Bain's printing telegraph possesses the grand element of permanent success—simplicity. Any person seeing it for the first time—that is, any person who can read—may be taught in five minutes to work it as well as those who are familiarly acquainted with its mechanism. One individual only is required for its manipulation. This person indicates what the telegraph has to do; the machine acts in accordance; and the intelligence to be conveyed from one place to another, however distant, is instantaneously communicated in print, without any one being present of necessity at the point to which it is transmitted, the instrument, in this respect, being self-acting.

A result so astonishing as this may well appear incredible. A visit to the Polytechnic Institution we have named, will, however, remove all doubt on the subject. "Seeing is believing" according to the proverb; and there, they who list may *see* the thing done. Recommending all sceptics to this satisfactory test, we proceed to particularly describe the *modus operandi* of this most interesting and very curious machine. The engraving will assist our explanations.

In Fig. 1, some machinery is represented in a frame, the whole supported on a common stool. By attentively examining its various parts it will be seen that there are three principal portions namely —a cylinder A, an ordinary clock wheel B, and a roller C. These three things rotate in the same way; the perpendicular axis of each is parallel with that of its neighbour, and the motion of all is consequently horizontal. Besides these principal divisions, there are other arrangements, apparently subordinate, but really important. It will be noted that the large cylinder goes round upon a spiral screw, the effect of which is gradually to elevate it during the rotation. From underneath this cylinder an arm projects, having connexion with a weight and pulley, so that, as the cylinder rises, the arm rises too, in consequence of the attached weight. Upon this arm the roller is fixed; and an ascending motion on its part, simultaneous with that of the cylinder, and corresponding exactly with it, is the result of the arrangement. The wheel between the two (B), is permanently fixed upon its axis.

The uses to which these separate parts are applied must first be described. The cylinder, which is removable at pleasure, carries the paper (round it) on which the letters are to be printed; the paper being, with equal facility, put upon or taken from it. The wheel, between it and the roller, contains upon its periphery, or edge, the letters of the alphabet regularly arranged, including a full stop. The roller is charged with ink. Due note must be taken that the letters on the edge of the wheel are made continually to press upon the inking roller whenever the former is in motion, by which means every letter is kept charged with ink, and ready to stamp its impression upon the paper on the cylinder; and it must further be observed, that only one letter can be printed at a time, in consequence of the roller-like shape of the parts. The spiral screw, on which the cylinder travels, secures the gradual elevation of the latter as it rotates, the object of which is to prevent the same surface of paper from being twice presented to the printing letters. In like manner, the ink is never taken by the letters twice from the same place on the roller, because, for the reason already assigned, the gradual ascent of the roller corresponds exactly with that of the cylinder. In the nicety of these details we discover evidence of the acute observation of the inventor. They may appear to be of minor importance in the estimation of those who are dazzled with the primary merit of successfully applying voltaic electricity as a motive power, but the practical printer will at once recognise an admirable attention to working results, without which, however brilliant may have been the original conception, it would want the attributes of an harmonious and therefore useful whole.

Before further description is given, let it be borne in mind, that the paper to be printed on is placed round the cylinder, and that the roller is charged with ink. The *lettered* wheel, working between the two, first receives ink from the roller, and is then ready to print upon the paper any letter that is turned towards it. The mechanical action, by means of which the wheel is first made to rotate until it presents to the surface of the paper the letter actually required, and afterwards to strike the paper, in order to produce an impression—which mechanical action is governed, or rather caused, by the electrical current—remains yet to be accounted for; but we will first describe the other part of the invention, namely, a dial-plate or disk (represented), an acquaintance with which will facilitate comprehension of what is to follow

In Fig. 2, it will be observed, that this dial-plate (also placed upon a stool) has a revolving hand B, and that the letters of the alphabet, with a full stop, are described in a circle upon it. This hand goes round by clock-work continually in action. An *ivory* peg (a non-conductor) arrests the progress of the hand, when required, by being placed in a hole in the plate between the first and last letters of the alphabet, the exact situation of which is indicated in the diagram. A shallow aperture for the point of the same peg is made on the plate underneath every one of the letters. If the person working the machine wants to make the hand stop at any particular letter, all he has to do is to place the point of the peg upon the corresponding aperture in the plate underneath that letter, and the hand is stopped; but the only place in which the peg can be introduced as a temporary fixture is the one we have mentioned. The object of this arrangement is to obtain regularity. *En passant*, we beg particular attention to these facts, because the movements of the wheel charged with the letters in the printing part of the machine, depend entirely upon the rotation of the hand on the dial-plate, the explanation of which will be given presently.

Underneath the stool which supports the dial-plate, a galvanic battery G is placed, which is, of course, the source of the electricity employed. To this battery are attached three wires D, which are first brought into metallic connexion with the hand of the dial-plate, and afterwards conducted E and G to various parts of the printing machinery. Two of these wires communicate with two electro-magnets E, by the action of which the required effects are produced; and the other is the return wire, the introduction of which is necessary in order to complete the galvanic circuit. One of the electro-magnets controls the operations of the letter-wheel, and the other gives motion to the cylinder.

Particular attention is requested to the small circle of dots A on the dial-plate. This circle is composed of pegs of ivory inlaid upon the dial-plate, the number corresponding with the letters on the outer circle. From the revolving hand projects a small metal pin, the point of which travels over the circle alluded to as the hand goes round. Ivory is a non-conductor. While the pin is passing over an ivory peg, the electrical fluid ceases to flow from the dial-plate to the other part of the machinery, because the interposition of the non-conductor breaks the current; but the moment the pin has passed from the ivory to the metal plate, the connexion is again restored, and the current flows to the electro-magnets as before. It is this alternate making and breaking the current which is the cause of mechanical motion by the agency of the electro-magnets acting upon springs and wheels.

Let us suppose the letter O is required to be printed by the telegraph. The peg which confines the hand at the full stop on the dial-plate is removed, and the hand then goes round. Its first movement is from A to B. In this passage, the pin we have just mentioned first establishes a current of electricity between the dial-plate and the two electro-magnets in the printing part of the machinery, and then breaks it immediately afterwards by passing on to the ivory. Let us now trace the action of this pulsation of the electrical current. Rushing along the conducting wires, it arms both the artificial magnets with the power of attraction for a fraction of a second of time. During this period one of them is brought into play upon the cylinder, which is compelled to rotate a given distance in consequence. The other acts upon the letter-wheel, which (by a simple but most ingenious mechanical arrangement, contained in an inclosed box, to be recognised in the diagram as having thereon the inventor's name) is made to rotate the exact distance between the letters A and B upon its edge, the latter letter, by the operation, taking the previous position of the former. A similar movement occurs with every subsequent letter until O is reached; that is to say, that as the hand of the dial-plate passes over the intervening letters, a current of electricity is established and broken with each, the effect of which is to make the letter-wheel advance a letter each time this is done, so that when the hand of the dial-plate is at O, the same letter is presented by the wheel to the surface of the paper, in readiness to give an impression. In a word, by this arrangement the letters on the wheel in the printing part of the machinery invariably correspond with those on the dial-plate. At whatever letter on the dial-plate the hand is arrested, the same letter is presented by the wheel to the surface of the paper, in readiness to be printed. This last operation is instantaneously effected. The moment the letter is in its proper place, a connexion is established (by pressing down a metal spring C on the frame-work of the dial-plate) between the battery and the magnet which works the wheel, which latter is forced against the paper on the cylinder, on which it leaves the impression of the letter. In this way letters are first formed into words, and words into sentences.

The uses to which this portable machine may be applied are innumerable. As an instantaneous conductor of intelligence from one place to another, however wide they may be apart, by night or by day, in fine or thick weather, and invariably with unerring exactitude, it must at no distant day, become an agent in the hands of every civilised government. The railroads, when completed, will extend from London, as a centre, to every port of importance in the country. If three wires were laid along the length of each, the distant termination being connected with the printing part of the telegraph, and the other with the dial-plate of the machine stationed in an apartment at the Admiralty, it would be the easiest possible thing to interchange communications between all the ports and London at the same moment of time, the passage of each communication, with its return reply, occupying but a few seconds, by the employment of a telegraphic code of signals. We take this to be a very near approach to the annihilation of time and space. At all events, news is transmitted from one place to another by the agency of the electro-magnetic printing telegraph with the speed of lightning.

Mr. Bain, the sole inventor and originator of this very remarkable machine—a machine as simple as it is ingenious—has given the result of his genius to the world without any hope of corresponding remuneration, indeed, of any remuneration at all, from ordinary sources. He has secured nothing by patent; and the consequence is that every manufacturer of philosophical instruments may make, and every company may adopt his printing telegraph, without the necessity of paying to the inventor any compensation whatever for so doing. Mr. Bain's electro-magnetic printing telegraph is no philosophical toy. It is a machine admirably adapted to the wants of our own and neighbouring governments; and it may with considerable advantage be also applied to a variety of objects in private undertakings.—*Polytechnic Journal.*

SUGGESTIONS ON MUSICAL STRINGS AND INSTRUMENTS.

BY LEWIS GOMPERTZ.

(Resumed from page 208, and concluded.)

"THE want of covered strings on the double bass causes the instrument not to go so low as it ought for its size, its lowest note being only one note and a half lower than the lowest note on a violincello, which is so much smaller; though in quantity of tone the former is, of course, much deeper and fuller in the low notes than the latter, which have, therefore, been mistaken by most persons to be an octave lower than they really are. It is true that it generally takes its passages an octave lower than the former, but that has nothing to do with the capacity of the instrument, which only exceeds the other as before stated by a note and a half.

"If, then, properly covered strings could be got, the long desideratum would be accomplished by adding a fourth string to the double bass; and thus a greater scale and lower notes would be obtained. In the *tenor* the first string is the same note as the second string of the violin, but the length of the former is greater, which tends to produce a stronger tone, but makes the string more liable to break; and the first tenor string ought, it appears, (contrary to custom) to be a little thicker than the second of the violin, but not with the view of preventing its breaking. In the *harp*, the body of this instrument being very small for bass notes, it renders such notes less assistance than is the case with the violincello, but in order to counteract this deficiency as much as possible, harp strings are very nearly double the length of those of the violincello: the lowest C on the harp being just twice as long as the lowest C sharp on the violincello; and what seems surprising is, that though harp strings are subsequently drawn up with nearly twice the force, still they stand tolerably well, while it is not very uncommon for the fourth string of the violincello, with little more than half the strain on it, to break, though of cat-gut, while the other is of silk, which is generally considered not so strong; whether owing to its being less loaded or to other causes remains to be discovered.

"The pitch to which strings can be drawn, might indeed be used as a test, to prove the tenacity of the materials proportionably to their weight and elasticity. If, for instance, we wished to know which was the strongest material for its weight, wire or cat-gut, supposing their elasticity were equal, we should only have to see which could be drawn up to the highest note, and that would be the strongest for its weight.

"But there seems reason to think that the most elastic material must produce the highest tone, because it has more latitude of spring, when each is drawn up nearly to their utmost; and, therefore, its vibrations must, if I am correct, be made in less time; and, according to this idea, I find that the treble iron or steel strings of piano-fortes are considerably shorter than the first cat-gut strings of the violin, which is about a third longer than the same note on the piano-forte, iron being less elastic than cat-gut.

"The thickness of a string also affects its tone, independently of its weight, as a thick string of a light material touches more air than a thin one of a heavy substance; this may cause a preference of one material to another, and also add to the effect of covering to strings.

"There seems to be some mistake entertained respecting the degree of depth and acuteness at which notes can be discerned. There are no doubt limits, but not those generally imagined, the present being, it seems, more owing to the faults of the means, than to the incapacity of the ear, to distinguish tones. Persons usually think when they find the very low notes of piano-fortes, &c. bad, that the tone itself is too low to be good, but this is not the case, the reason is, that the string is too short, if even it be as long as the instrument itself; perhaps, also, the belly of the instrument is too small, and the extreme treble notes are bad because the material of the strings are too weak to bear being longer, and perhaps the belly is too large.

"*Seraphines* produce very fine notes, as low as the lowest notes which are not good in piano-fortes.

"But the tone of a string on an instrument is not all owing to its own vibrations against the air; this, in fact, causing but the smallest part of the tone, as may be proved by the treble tones of a string stretched without its pressing on a body;—the chief of the tone being by the vibrations of the body itself, which, acting by means of a much larger surface than that of the mere string, does the most execution, notwithstanding that its vibrations are much smaller. A string in vibrating on an instrument is no where at rest, not even at the nut and the bridge; and it is the motion of the part resting on the bridge which produces the chief effect; if this part did not move, the body would be of no use, but as the string vibrates, the bridge and nut resist, and the feet of the bridge resting on the belly of the instrument, which is of thin and yielding wood, communicates some motion to it; this being in violins, &c., communicated to the back by means of the sound post, (which, for what reason I know not, is omitted in the harp, guitar, and piano-forte,) likewise by the confined air in the body, so that the two surfaces vibrate in conjunction with the string, or even with chords, and strengthen the tone.

"The reason why the body of an instrument increases the tone, does not seem to be because it is hollow, so as to cause a reverberation or echo, as is generally imagined, but merely because it presents a larger surface against the air. It is admitted that sound is increased in a hollow confinement, by means of reverberation; yet this increase of tone only affects the ears of persons who are *within* the place, and would not be perceived by a person outside. The motion of the body, however, is very different to that of the strings; the first being slow and strong, and the latter quick and light, a great pressure would be required to stop the vibrations of the body, while a slight touch would stop the string. The action of the body is similar to what would result if a flat board were fastened perpendicularly to a stick like the instrument used by scavengers, and this even put in water and moved up and down so as to disturb the water. With respect to the goodness of an instrument, there seems to be a certain size of surface and thickness of wood best adapted to it, while the chief object seems to be to gain their points, and besides this the goodness seems to depend in the body, obeying and undoing itself to every note, and not sounding its own note in opposition to that of the string, every instrument having a note of its own, independently of the strings, which would be heard by giving the unstrung body a blow as with a drum, and this may cause one note on an instrument to be better than another.

"Some persons have thought they could improve the tone of a low instrument by having additional strings on it, to respond to those played on, but if any advantage exist in this it must only be in the additional strings not being interrupted by the bow and the rosin, which must always produce a slight grating against the string, as the bow goes only one way during a note, and the string backwards and forwards; half of the vibrations thereby being opposed, so that it is rather curious that a note should sound at all, but that it does sound is certain; and the additional strings cannot, it seems, add strength to the tone, because, though they sympathize in the motion of the original strings, they are, through the medium of the air, only pulled to and fro by them; and it is plain that if the air move the string, the string cannot move the air, we might as well suppose that two men might run, and each at the same instant pull the other on; the additional string, in fact, is a clog to the first, though not so great a clog as if the second string could not vibrate, as any body in the neighbourhood of a vibrating body tends to stop its motion."

SILICON; OR, THE BASE OF FLINT.

Silica or siliceous earth, the oxide of the present element, is the most abundant of all the matters which compose the crust of the globe. It constitutes sand, the varieties of sand-stone and quartz rock, and enters into felspar, mica and a prodigious variety of minerals, which form the basis of other rocks.

Preparation.—Silica may be decomposed by heating it with potassium, which deprives it of oxygen; but a better process for obtaining silicon, is to heat the double fluoride of silicon and potassium, with 8 or 9-10ths of its weight of potassium. The double fluoride employed, is prepared by neutralising fluosilicic acid with potash. A different process is suggested by Berzelius, which consists in heating potassium in a tube of hard glass with a small bulb blown upon it, which is filled with the vapour of the fluoride of silicon, supplied from the ebullition of that liquid contained in a small retort connected with the glass tube. The potassium burns in this vapour, and at the end, silicon is found, with fluoride of potassium, in the place of the metal. But the silicon from all these processes is always in combination with a little potassium, and mixed with a little fluoride of silicon and potassium unreduced. Hence, on applying cold water to the mass, hydrogen gas is disengaged, and potash formed, and the silicon separates. The potash thus produced can, with the aid of hot water, dissolve the silicon, which then oxidates and becomes silica, so that cold water only must be employed to wash the silicon, which may be thrown upon a filter. After a time, the liquid which passes has an acid reaction, which arises from its dissolving an acid double fluoride of silicon and potassium, of sparing solubility, which has escaped decomposition, and is mixed with the silicon. The washing is continued so long as the water dissolves anything.

Properties.—The silicon which is thus obtained is, in its pure state, a dull brown powder, which soils the fingers, and when heated in air or oxygen, inflames and burns, but is never more than partially converted into silica. It may be ignited strongly in a covered crucible without loss, and then shrinks in dimensions, acquires a deep chocolate color, and becomes so dense as to sink in oil of vitriol. By this ignition the properties of silicon are altered to a degree which is very remarkable in a simple substance. It was previously readily soluble in hydrofluoric acid, with evolution of hydrogen, and in caustic potash, but it is now no longer acted upon by that or any other acid, nor by alkalies. The ignited silicon also refuses to burn in air or oxygen, even when intensely heated by the blow-pipe flame. Charcoal, it will be remembered, is more dense and less combustible after being strongly heated; but that substance is not altered by heat to the same extent as silicon. Mixed and heated with dry carbonate of potash, silicon in any condition is oxidated completely, its action upon the carbonic acid of the salt being attended with ignition, and carbon liberated. Silicon burns when heated in sulphur vapour, and forms a sulphuret, which water dissolves, but decomposes at the same time, sulphuretted hydrogen and silica being produced, and the last, despite its usual insolubility, retained in solution. Silicon likewise burns in chlorine; and the chloride of silicon may be otherwise formed by transmitting chlorine over a mixture of charcoal and silica ignited in a porcelain tube. The silica is decomposed by neither charcoal nor chlorine singly, but acting together upon the silica, these bodies produce carbonic oxide and chloride of silicon. This compound is a volatile liquid.

Silica or Silicic Acid.—This earth, which is the only oxide of silicon, constitutes a number of minerals, nearly in a state of purity, such as rock-crystal, quartz, flint, sandstone, the amethyst, calcedony, cornelian, agate, opal, &c. The first chemical examination of its properties and compounds is due to Bergman.

Preparation.—Silica may be had very nearly, if not absolutely pure, by heating a colorless specimen of rock crystal to redness and throwing it into water, after which treatment the mineral may easily be pulverised. It is obtained in a state of more minute division, by transmitting the gaseous fluoride of silicon (fluosilicic acid) into water; or by the action of acids upon some of the alkaline compounds of silica. Equal parts of carbonate of potash and carbonate of soda may be fused in a platinum crucible, at a temperature which is not high; and pounded flint or any other siliceous mineral, thrown by little and little into the fused mass, dissolves in it with an effervescence due to the escape of carbonic acid gas. The addition of the mineral may be continued so long as it determines this effervescence. The mass being allowed to cool, is afterwards dissolved in water acidulated with hydrochloric acid, which takes up the silica as well as the alkalies; the liquor is filtered and then evaporated to dryness. The silica may contain a little peroxide of iron or alumina, to dissolve which the saline mass, when perfectly dry, is moistened with concentrated hydrochloric acid, and after two hours the acid mass is washed with hot water. The silica remains undissolved; it may be dried well and ignited.

Properties.—Silica so prepared is a white, tasteless powder, which is rough to the touch, and feels gritty between the teeth. It is extremely mobile when heated, and is thrown out of a crucible, at a high temperature, by the slightest breath of wind. It is absolutely insoluble in water, acids and most liquids. Its density is 2.66. The heat of the strongest wind-furnace is not sufficient to fuse silica; but it melts into a limpid colorless glass in the flame of the oxyhydrogen blow-pipe. Silica is found frequently crystallised, its ordinary form being a six-sided prism terminated by a six-sided pyramid, as in rock-crystal. Sometimes the prism is very short or disappears entirely, and the pyramid only is seen, as in ordinary quartz.

Soluble Silicic Acid.—The preceding description applies to silica after it has been dried or heated, but silica can also be obtained in a state in which it is soluble in dilute acids and even in water. The oxidation of the sulphuret of silicon, in water, gives silica in this condition; the solution when concentrated, becomes a gelatinous mass, like size. When the gaseous fluoride of silicon is absorbed by water, silica separates in large quantity in that gelatinous condition, and this jelly is soluble in water although it requires a large quantity to dissolve it. The solution of silica was found by Berzelius to be insipid, and not to redden litmus; by evaporation of the liquor the silica is deposited in the form of an earthy mass without a trace of crystallisation, and capable of dissolving again in water. It is observed, however, that when sulphuric or hydrochloric acid is added to the solution during evaporation, the silica obtained is no longer the soluble, but the former insoluble variety. The fixed alkalies and their carbonates, it is curious, effect a transmutation of the opposite kind, for when insoluble silica is boiled with them, it is gradually converted into the soluble species and dissolves. Berzelius finds that this change supervenes, without decomposition of the alkaline carbonate or any escape of carbonic acid. The alkali in this solution may be saturated completely with an acid, without any silica precipitating, which proves that that body is dissolved in the water and not in the alkaline carbonate.

The water of springs and wells always contains a little soluble silica, which can only be obtained by evaporating the water to dryness. In some mineral waters the proportion of silica is very considerable, and it is often associated with an alkaline carbonate, as in the hot alkaline spring of Reikum in Iceland, and in the boiling jets of the Geyser, which deposit about their crater an incrustation of silica. There can be no doubt likewise that much of the crystalline quartz in nature besides all the agates, calcedonies and siliceous petrifactions have been formed from an aqueous solution.

The soluble silica seems to exist in the class of minerals called *zeolites*, which also contain water, and many of which dissolve entirely in dilute hydrochloric acid. But it may be obtained from any silicate by fusing it with an alkaline carbonate, and afterwards dissolving in dilute acid. The solution, on concentration, gives a transparent jelly, which is highly tenacious, and cracks on drying, forming a mass like gum. When completely dried in the air, the mass is no longer soluble in water or acids. It contains a small quantity of water, which, however, according to Berzelius is hygroscopic; silica affording him no definite hydrates, like those of other acids. But Dr. Graham says, "I should still be disposed to look to the state of hydration, however feebly the water may be retained, for an explanation of the differences between the soluble and insoluble varieties of silica. Hydrofluoric acid is the only acid which dissolves silica in both conditions."

Silicates.—Although silica has no acid reaction, it is certainly an acid, and is indeed capable of displacing the most powerful of the volatile acids at a high temperature. It is capable of uniting with metallic oxides, by way of fusion, in a great variety of proportions. Its compounds with excess of alkali, are caustic and soluble, but those with an excess of silica are insoluble, and form the varieties of *glass*. With alumina it forms the less fusible compounds of porcelain and stoneware. A large number of mineral species are also earthy silicates. It seems probable that silicic, like phosphoric acid, forms several classes of salts, of which those containing the largest number of atoms of base are the most soluble, and afford, when decomposed the soluble silica. At the same time some difference may exist between the silicic acid itself, as it exists in these different classes of salts, such as there is between ignited and unignited silicon.

THE COTTON PLANT.

There are many species of this plant, and their number is so constantly increased by the researches of botanists, that the varieties appear scarcely to have any limit. Linnæus enumerated only four kinds; Lamarck, in the "Encyclopedie Méthodique," recognizes eight; Cavanilles, in his "Sixth Dissertation on the Monadelphia Class of Plants," adds two other species to this number; and Desfontaines, Poiret, and Rœusch have each described a new species.

Dr. Rohr, who resided during many years at the island of St. Croix, where he cultivated cotton with extreme care, and studied all the characteristics of the plant, describes thirty-four distinct species;—but to these, much to the regret of the botanical student, he affixes only their popular names, and it cannot therefore be ascertained in what respects they agree with the different species which have been elsewhere described in botanical phraseology.

Mr. Bennet, a cotton cultivator in Tobago, who was an accurate and indefatigable observer of the plant, remarked more than a hundred varieties, and considered them as never ending. Of the species already enumerated, it is most probable that some are only varieties occasioned by the different effects of culture, soil, or climate, on a plant which has been under cultivation for so many ages; and it is scarcely possible to determine what plants, so differing, can be regarded as forming separate species, or as being only simple varieties: while, at the same time, the information of the scientific man is so distinct from that of the practical planter, that it becomes a subject of no small difficulty to combine the knowledge obtained from each into one accordant whole.

To the cotton planter, it is a matter of much interest to become acquainted with all these distinctive varieties, as some are incomparably more valuable than others, in the quantity and quality of their produce. Some yield their downy harvest twice in the year, others only once. Some bear cotton of a long and delicate fibre, and of a beautiful whiteness, while others are found to be short and coarse, and of a bad color. For want of this knowledge, so little regard is in general paid to the selection of the seed, and the improvement of the stock, that the careful cultivator in first forming a plantation is mortified at finding an endless variety among his plants, and can only hope to improve his plantation by his own personal experience, at the cost of much labour and many failures.

It would be tedious and unprofitable to the general reader to go into any minute particulars of all the varieties of the cotton plant, and therefore the distinctive characters, and the points of difference of those most in cultivation, will only be briefly noticed.

The *Gossypium herbaceum*, or common herbaceous cotton plant, is the species most generally cultivated. It is annual and rises scarcely to the height of eighteen or twenty inches. It bears a large yellow flower, with a purple centre, which produces a pod about the size of a walnut. This pod, when ripe, bursts, and exhibits to view the fleecy cotton, in which the seeds are securely embedded. It is sown and reaped like corn. This species is a native of Persia, and is the same which is grown in Asia Minor, some parts of the United States of America, in Sicily, at Naples, and in Malta.

The *Gossypium arboreum*, or tree cotton, is of much larger growth. If left without being pruned, to luxuriate to its full height, it has sometimes attained to fifteen or twenty feet. The leaves grow upon long hairy foot-stalks, and are divided into five deep, spear-shaped lobes. This shrub is a native of India, and probably the same as that described by Marco Polo, as existing at Guzzerat.—"Cotton," says the Venetian traveller, "is produced here in large quantities, from a tree that is about six yards in height, and bears during twenty years; but the cotton taken from trees of that age is not adapted for spinning, but only for quilting."

The *Gossypium Indicum*, or Indian cotton, is another species not very dissimilar to the last; it has not a ligneous stem, and its branches are more hairy, especially at their upper parts. The shape of the leaf likewise somewhat differs from that before described, this being divided into three convex lobes. The stem rises to the height of ten or twelve feet, and continues in full bearing during several years. It is sometimes called likewise Barbadense, or Barbadoes cotton—Barbadoes having been the first of the West-India islands into which it was transplanted from the East. This and the preceding species are both cultivated in the West Indies.

The *Gossypium vitifolium*, or the vine-leaved cotton plant, differs from the Indian, just described, in the form of its leaves, which resemble those of the grape vine. This is indigenous to the East Indies, and is cultivated at the Mauritius.

The *Gossypium hirsutum*, or hairy cotton plant, is another species; it has herbaceous stalks branching laterally, rising almost three feet high, and covered with a thick down; the foot-stalk and midrib of the leaf are likewise hairy, and the leaf is divided into three unequal lobes. This plant is biennial, or even perennial in the warmer provinces, but in colder climes it becomes an annual, which change is sometimes found to take place in regard to other objects of cultivation in those situations where the winter frost can attack the root of the tender plant, and cause it to lose its vegetating power. This species is said to be indigenous to South America.

Another species is distinguished by the name of *Gossypium religiosum*. No reason is assigned why Linnæus should have bestowed on it so singular a title. The solution of the question was thought to be discovered, on reading in Stedman's Surinam, that the negroes on the coast of Guinea have much veneration for the wild cotton tree; unfortunately, however, on inquiring farther, we find that the tree associated with religion by the Africans, is the lofty bombax, bearing no similitude to this diminutive plant, but resembling, though far surpassing our largest oaks in elegance and magnitude. The exalted dimensions and outspreading branches of the African bombax have ensured the favor and reverence in which it is held among a simple people, who, having "no long drawn aisle or fretted vault" raised for the observances of religion, have consecrated a natural temple under the ample shade of which their *gadoman*, or priest, delivers his lectures to the assembled audience. The little shrub called *G. religiosum*, only attaining to three or four feet in height, cannot therefore, by the most ingenious conceit, be made to show any connexion with the custom of the natives of Guinea, and we must consent to leave the origin of its present designation in obscurity. Lamarck calls this species *tricuspidatum*. Its stem is upright, of a slightly red color, and very hairy. The leaves are sometimes entire, but more frequently divided into three or four not very deep lobes. The flowers grow in a similar manner to the others, but differ in color, being first white, then changing to rose, and finally to red. It is not known of what country this is native. Lamarck believes that it is indigenous to the lowest latitudes of America. Cavanilles supposes that it comes from the Cape of Good Hope. It is cultivated in the Mauritius. There are two varieties of this spécies,—in the one the cotton is extremely white, in the other it is of a yellowish brown, and is the material of which the stuff called nankin is made; it may therefore be presumed that this species is a native of China, whence nankin cloths are obtained. The yellowish brown color of Chinese nankins is therefore the natural color of the cotton, and is not imparted by dyeing. The name is derived from the city of Nankin, to which place the manufacture of these cotton stuffs was peculiar.

The color of the nankins was long thought to be artificial, and Van Braam, who travelled in China with a Dutch embassy at the end of the last century, informs us, that the European merchants sent to request that the nankins for their markets might be dyed of a deeper color than those last received. The fact was, the Chinese had made the last lighter than usual, in consequence of a great and sudden demand, which obliged them to mix their common white cotton with the yellowish brown.

The various species of cotton just described, have been distinguished according to their respective botanical characteristics. Dr. Rohr classes the species and varieties by the different appearances of the seed; other cultivators arrange the various kinds according to the facility with which the cotton is ginned, or divested of its seed; some again consider the distinctive difference to reside in the shape of the seed-pod, the number of its divisions, or the manner and time in which the cotton is retained in its place after the bursting of the pod; while others believe the only circumstances worthy of attention in the classification to be those which regard the staple or fibre.

Very white cotton is not considered the best; a slightly yellow tinge, when not the effect of accidental moisture or of an inclement season, is indicative of greater fineness.

The number of seeds in one pod vary according to the different species; the pods of some containing only ten or twelve seeds, others as many as thirty; while in all there is a marked difference in color, shape, and size.

(To be continued.)

REVIEW.

A Concise and Practical Treatise on the Principal Diseases of the Air Passages, Lungs, and Pleura. By A. Catherwood, M.D. C.M., &c.—Price 7s. 6d.—Duncan.

Although we are not in the habit of reviewing medical books, yet we have, for once, stepped aside from our usual course, and for three reasons. Firstly, because the author is well known in London as one of the most eminent physicians for these diseases. Secondly, because we have cause to believe, that a very large proportion of our readers are of the faculty; and thirdly, because these diseases, besides being the most frequent, are also the most fatal in our changeable climate; so that all have a vital interest in knowing their origin and cure. The author tells us in the preface, that "he has endeavoured to adapt the language to the comprehension of the non-medical reader, and, as far as possible to arrange the various subjects, so that they may be most easily understood, compared and referred to."

The work treats of ordinary coughs and colds of every kind; whooping cough, croup, inflammation of the lungs, dropsy of the lungs, asthma, consumption, inflammation of the pleura, water on the chest, and numerous other disorders—their causes, signs, progress, and treatment. The style shows that the learned doctor has written from long experience, and not with the too common desire of making up a book. The prescriptions given throughout are truly valuable. We strongly recommend the work to all our readers, medical or non-medical.

MISCELLANEOUS EXPERIMENTS.

Prepare a strong solution of phosphorus in sulphuric ether, and dip a piece of white silk in the solution; then, when the ether has evaporated, and the phosphorus begins to fume, apply a solution of nitro-muriate of gold, made by dissolving the crystals of that salt in distilled water; the silk will in an instant be covered with a *splendid* coat of *metallic gold.*

Proceed as in the last experiment, and instead of the solution of gold, apply, with a camel's-hair pencil, a solution of nitrate of silver. Here the silver will instantly be restored to its *metallic brilliancy,* and frequently attended by *spangles* of a beautiful *blue.*

If a bit of white silk be immersed in an ethereal solution of gold, and dried, the application of phosphorized ether will only impart a *brown* color to the silk; but if, as soon as the phosphorus begins to fume, it be placed on the palm of the hand, and breathed on for a considerable time, the *brown* will be succeeded by a *purple tinge,* and the *metallic lustre* of the *gold* will soon begin to appear.

When antimony is well fused upon charcoal, and if, at the moment when its surface is not covered with any particle of oxide, we throw it suddenly upon the ground, the globules, into which it divides in its fall, *burn* with a very *lively flame,* throwing out on all sides *brilliant sparks,* different from those of any other metal.

Mix five or six grains of sulphuret of antimony with half its weight of chlorate of potass, and then, if a sudden stroke be given to the mixture, upon a steel anvil, it fulminates with a loud report, emitting, according to Fourcroy, a *flame* as brilliant and *rapid as lightning.*

Evaporate to dryness a solution of gold, made with nitro-muriatic acid, and dissolve the crystals in a sufficiency of pure water to prevent the crystallisation of the metallic salt Thoroughly moisten a little magnesia with this aqueous solution, and place the mixture in the sun's rays. A change of color will soon be apparent. It will first take a *faint violet* hue, and in a few hours the whole will have acquired a very *deep purple.*

Moisten a little magnesia with some of the solution as before, and then dry the mixture in the *dark.* If it be then submitted to the action of the sun's rays, it will acquire only a *faint violet,* even *by several hours* exposure.

If the mixture employed in the last experiment be now thoroughly *wetted* with pure water, and again placed within the rays of the sun, its color will *rapidly change,* and will acquire a *deep purple* approaching to *crimson.*

Moisten a piece of white riband with the aqueous solution of gold, and dry it thoroughly in the dark: then suspend it in a clean, dry, transparent phial, and cork it close with a dry cork. Expose the riband, thus secured, to the strong light of a bright sun, for half an hour, and only a *faint* appearance of *change of color* will be perceived.

Take the riband out of the phial that was employed in the last experiment, and *wet* it well with distilled water. If it be now exposed to the sun's rays, it will instantly *change* color, and will quickly be stained of an *indelible purple.*

Dissolve dry nitrate of silver in pure water; add a little oil of turpentine, shake the mixture, and cork it close. Submit the phial with its contents to the heat of boiling water for an hour, when the metal will be revived, and the inside of the phial, where the oil reposed on the aqueous solution, will be beautifully *silvered,* the revived metal forming a *metallic ring,* extending quite round the phial.

Immerse a slip of white silk in a solution of nitro-muriate of gold in distilled water, and dry it in the air. Silk thus prepared will not be altered by hydrogen gas: but if another piece of silk be dipped in the solution, and exposed while *wet* to the same current of hydrogen gas, instant signs of metallic reduction will appear; the color will change from yellow to green, and a brilliant film of *reduced gold* will soon glitter on its *surface.*"

If a piece of silk be immersed in a solution of nitrate of silver, and dried in a dark place, and then submitted to hydrogen gas, the silver will not be reduced; but if exposed while *wet* to a stream of the same gas, the surface will quickly be coated with reduced silver; various colors, such as blue, purple, red, orange, and yellow, will accompany the reduction, and the *threads* of the *silk* will look like *silver wire. During these experiments the silk should be constantly kept wet with distilled water.*

Dissolve some crystals of chloride of tin in distilled water, then dip a piece of white silk in the solution, and dry it in the air. If this be now immersed in hydrogen gas, no change will be observed; but if it be exposed while *wet* to the same current of gas, the reduction will soon commence, attended with a great variety of beautiful colors, as *red, yellow, orange, green,* and *blue,* variously intermixed.

2.

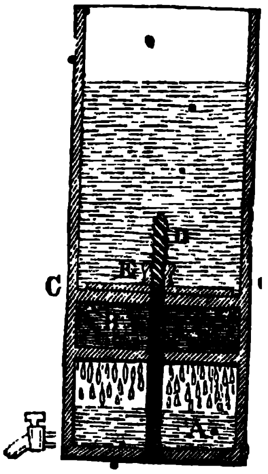
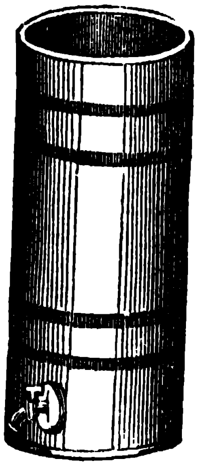
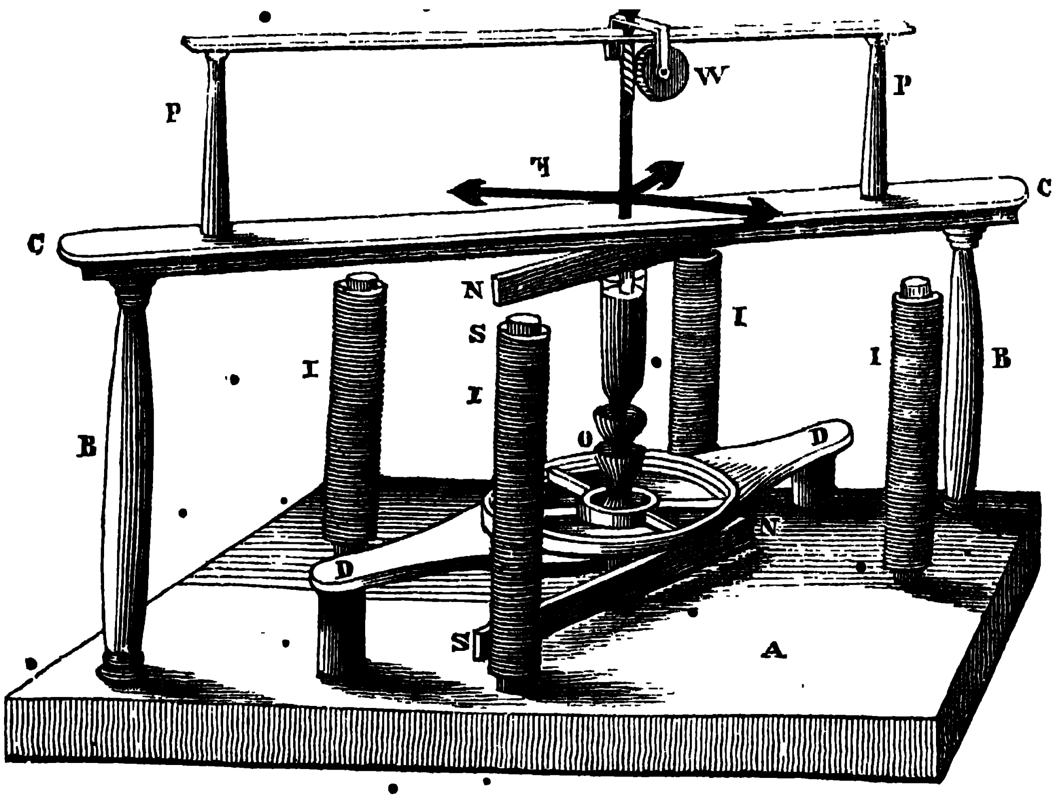


Fig. 1.



MAY'S RAPID FILTER.



STURGEON'S ELECTRO-MAGNETIC ENGINE, &c.

MAY'S RAPID FILTER.

It is highly important to the health of families, that water intended for their daily consumption should be free from all impurities.

Good and clear water is also a valuable acquisition to such manufacturers as paper makers, dyers, bleachers, and calico printers; and in order that families and manufacturers should have a constant and copious supply of pure water, filtration, on a large scale, is necessary.

The systems of filtration already used by the public, furnish filtered water in such trifling quantities as to be of service only to small families, in addition to which, great inconvenience is experienced by the filters being constantly out of repair, and from their having to be taken away to be put to rights; while manufacturers, like the paper maker, dyer, bleacher, calico printer, &c., who require such large quantities of filtered water as 120,000 gallons per day, are without any system of filtration whereby they can obtain pure water in such large quantities.

Again, the vinegar distiller, oil merchant, and sugar refiner, are without any rapid system of filtration by which they can clarify their liquids; but by the method now to be explained, oils, vinegar, and sugar juice, are clarified in the most perfect manner, and at a very rapid rate.

Fig. 1, of the accompanying engravings, is an external representation of a patent rapid filter, called No. 1, which is eight inches in diameter, and twenty inches high, and capable of filtering upwards of 1500 gallons of water, or other similar liquid, per day of 24 hours.

Fig. 2, is a section of the same; A, the false bottom or well into which the filtered liquid is received, covered with a perforated plate, above which there is a layer of horse-hair or serge; B is the filtering medium, which consists of prepared cotton divested of every particle of dirt and grease; C is an iron or earthenware plate pierced with fine holes, or covered with wire gauze. A galvanized iron rod D passes from beneath the bottom of the filter, through the filtering materials, and terminates in a screw at its upper end.

In preparing this filter, the cotton being already thoroughly cleansed, is soaked in clean water, and then packed or kneaded into the filter, taking care to press it well against the sides of the containing vessel; the plate C is then placed upon the cotton, and above it a circular iron frame. The nut E is then screwed upon the upright rod until the filtering medium is sufficiently compressed.

In the construction of large filters for the supply of paper makers, dyers, calico printers, &c., requiring as many as 10,000 gallons of water per hour, the arrangement is slightly varied. In this case the rod D is dispensed with; the cotton is packed or kneaded on to the covering of the false bottom, the full size of the tank or reservoir, and pressed down by an iron frame-work covered with wire gauze. A screw and lever are employed in the first instance to give the required pressure, when iron rods, fitted with set screws, are slid down metal grooves placed two on each side of the vessel, which retains the parts in their proper position when the screw is removed.

The patentee claims the following advantages for his system of filtration, viz.:

1. That water may be filtered to any extent.
2. That wines, oils, vinegar, sugar juice, cyder, and all liquids, may be filtered without injuring their quality, taste, or color.
3. That the size of the filters are small, in comparison with the large supply of filtered water. For example, a filter of eight inches in diameter, by twenty inches high, will filter water at the rate of 1500 gallons per day.
4. That filters can be easily cleaned, and upon the premises where they may be situated.
5. That the water is not made hard by filtration, the filtering medium being quite free from chemical preparation, which is worthy the attention of dyers, bleachers, calico printers, color makers, &c., who require pure water without being made hard by filtration.

The advantages that strike us as being most important, are the rapidity of its action, and the facility of cleansing, which latter can at any time be effected in a few minutes, either by washing the cotton, or by putting in a fresh supply.

With respect to the rapidity of operation, one which we inspected at the depôt in Chatham Place, not above two feet in diameter, was filtering at the rate of 7000 gallons a day.

Where reservoirs, tanks, or back-waters are on the premises of large establishments, filtered water can be had to any extent, as it is only necessary to place one or more of these filters in communication with the supply of water, and the filtered water can be drawn off as fast as it may be required.

Families, hotel-keepers, and tavern-keepers, can have these filters fitted to their house cisterns, by which means filtered water can be had to any extent, for culinary and laundry purposes, as well as for the service of the bed chambers and bath rooms. —*Mechanics' Magazine.*

STURGEON'S ELECTRO-MAGNETIC ENGINE, &c.

A A A A represents a stout square board, which forms the base of the engine. In two opposite corners of the base board, are fixed the two upright pillars B B, which carry a cross piece C C. In this cross piece are fixed two other smaller pillars P P, which also carry a cross piece. In the centre of the engine is a vertical shaft, which turns freely in two metallic collars; one of which is in the centre of the base board, and the other in the centre of the cross piece C C.

About half way up the shaft are two circular channels, one above the other, as seen in the figure. Through the centre of these channels, and at right angles to their planes, the shaft passes, and is fixed to them. Lower down, the shaft passes through the centre of an opening in the cross piece D D, also supported by two short pillars. On this cross piece, and concentric with the shaft, are fixed four quadrantal metallic plates, separated from each other by narrow radial openings.

Near the top of the shaft, and at right angles to it, is fixed a compound bar magnet N S, each magnet of which is about eighteen inches long, one inch broad, and half an inch thick. Near to the bottom of the shaft is fixed another similar compound magnet N S, with its poles in the opposite direction to the former.

In a circle concentric with the shaft, and at an equal distance from each other, are fixed in the base board, the lower extremities of four cylindrical bars of soft iron I I I I, each of which is inclosed by six coils of copper wire. The coils around each cylinder are separated from each other by intervening cases of oil silk. Each set of extremities of these copper wires is soldered to one stout copper wire; hence the extremities of the twenty-four coils terminate in eight of these latter wires, four of which proceed from the lower extremities of the coils, and are soldered to the four quadrantal metallic plates, one to each. The other four stout wires proceed from the upper parts of the coils and terminate by proper connexions in the circular channels, which are partly filled with mercury. Through the sides of the channels pass four metallic stems, two through each, their inner extremities being in contact with the mercury in their respective channels. The stems of each pair are placed at 90° from each other, and the whole at right angles to the shaft. The right angle which the upper pair forms, is on the opposite side of the shaft to that formed by the lower pair. From each stem hangs a metallic wire, reaching obliquely to its respective quadrantal plate on the cross piece D D, which maintains a connexion between these plates and the mercury in the circular channels; transferring the electric current from one plate to another, and consequently from one coil to another, in their progress of revolution. To prevent the figure being distorted, none of these connecting wires are drawn.

The engine is put into motion by the application of two cylindrical voltaic batteries of a single pair each, the metals being placed in two porcelain jars, each of which holds about three pints. These batteries are connected with the conductors of the engine at their terminal cups. One battery at each end of the lowest cross piece D D.

The connexions being properly made, the iron cylinders become magnetic in succession, and by the joint attractive and repulsive forces of the permanent magnets N S, N S, and the temporary magnets I I I I, the former, with the shaft and appendages, are pulled and driven round, the action being carried on in the following manner:—

Imagine that the pole N of the permanent magnet is placed directly between the poles S and N of the temporary magnets; it will by this means be attracted by the former, and at the same time repelled by the latter. Hence it will be urged by both these forces towards the pole S. If now the contrivance be such, that the voltaic connexions be broken just before the pole N arrives at S, the extremity S of the iron bar will become neutral; but the momentum of the machine will carry the pole N to beyond this neutral point. Now conceive that the pendent wires have been carried from their last quadrantal plates to the next in succession. The currents by this means have been reversed in all the coils, and a corresponding inversion of polarity has taken place in the vertical iron bars; hence, when the pole N has just passed the first bar, and whilst still in motion by its acquired momentum, it will again be urged on by two other forces, in a similar manner as by the two first. For the extremity having changed its polarity, it will now repel the pole N and drive it onward, whilst at the same time it will be attracted by the next bar in succession. And, in consequence of similar changes of polarity taking place in all the four bars, the pole N is kept continually revolving.

All that has been said respecting the pole N, applies equally to the opposite pole S of the same magnet. So that by this means, the magnet and its appendages are continually urged on by four forces, two attractions and two repulsions: and by considering that the lower magnet N S is, by the contrivance, also urged on at the same time, and in a similar manner, by four other like forces; it will easily be understood that the two magnets, with the shaft to which they are attached, are kept in motion by eight forces; four of which are attractive and four repulsive. Such is the contrivance for keeping the machine in motion.

To the upper end of the shaft is attached a vertical spindle, carrying an endless screw near its upper extremity, and revolving as the shaft revolves, in a collar in the upper cross piece. Near to the lower end of this spindle is a fly with three arms, equidistant from each other, and each terminating with a heavy brass crescent. It was originally the fly of a roasting jack. The endless screw works in the teeth of a brass wheel, also a part of the old jack. The arbor of this wheel runs in a frame attached at right angles, to the upper cross piece.

CHLORATE OF POTASH.

THIS interesting saline compound has become the object of a pretty extensive manufacture, in consequence of its application to make matches for procuring instantaneous light, and a detonating powder for fire-arms. It may be prepared both in the humid and dry way.

Having made a strong solution of purified potash, or carbonate of potash, with from two to three parts of water, we pass through it in a Woulfe's apparatus a current of chlorine gas, till it ceases to absorb any more. Chloride of potash and chloride of potassium alone are formed as long as there is an excess of alkali in the solution; but afterwards in the further reaction of the materials, the chloride passes into the state of a chlorate, and, as such, precipitates from the solution. During the first half of the operation, that is, till the potash be about one half saturated with chlorine, as indicated by litmus paper ceasing to be darkened and beginning to be blanched, only the chloride of potassium or muriate of potash falls. The process should be interrupted at this point in order to remove the salt, to wash it, to add the washings to the liquor, and then to transmit the gas freely through the solution. As the operation advances, less muriate of potash is formed, and at length nothing but the pure chlorate is separated in crystals. When finally the bubbles of gas pass through without being sensibly absorbed, the process is known to be completed; the liquid may then be allowed to settle, and be poured off from the crystals of chlorate of potash, which are purified from the muriate by dissolving them in three times their weight of boiling water, and filtering the solution while hot. On its cooling, the chlorate will separate in pearly-looking crystalline plates. It may be rendered quite pure by a second crystallization, in which state it does not affect solution of nitrate of silver.

The above potash lye usually gets a reddish tint in the course of the process, in consequence of a little manganesic acid coming over with the chlorine, but it gradually loses this color as the saturation becomes complete, when the solution turns yellow. The tubes for conveying the gas should be of large diameter, if they be plunged into the saline solution, because the crystallization which takes place in it is apt to choke them up. This inconvenience may, however, be obviated by attaching to the end of the glass tube, a tube of caoutchouc terminated in a small glass funnel, or simply the neck of a caoutchouc bottle with part of its body, whose width will not be readily closed with a saline crust. The residuary lixivium may be used against another operation, or it may be evaporated down to half its bulk, and set aside to crystallize, whereby some more chlorate will be obtained, mixed indeed with muriate and carbonate, from which, however, it may be separated by a second crystallization. In general the pure chlorate obtained does not exceed one-tenth the weight of the potash employed; because in thus treating potash with chlorine, five-sixths of it are converted into muriate of potash and only one-sixth into chlorate, and a part of the latter adheres to the muriate, or is lost in the mother waters of the crystallization.

The chlorate of potash may be more conveniently manufactured, like that of lime, in the dry way. St. Romer patented at Vienna the following method for that purpose in 1821:—Ten pounds of crystallized peroxide of manganese are to be finely pulverized, mixed with ten pounds of plumbago, and thirty pounds of common salt, and put into a leaden retort. From the middle of the helmet-shaped lid of this vessel, a lead tube, two feet long and two inches wide, conducts to the receiver, which is a square earthen pan, hard glazed both within and without, of the same capacity with the retort. The end of the tube must be made fast to a frame at the height of six inches above the bottom of the receiver. Upon its inner sides four inches apart, brackets are to be fixed for supporting a series of laths or shelves of white wood, on which a number of little paper or paste-board boxes are to be laid. In these boxes ten pounds of the purest carbonate of potash, prepared from tartar, are to be spread. The receiver must now be covered with a lid made tight by a water lute. Twenty pounds of concentrated sulphuric acid previously diluted with sixteen pounds of water, and then cooled, are to be poured upon the mixed materials in the retort, the lid immediately secured, with the tube adjusted in the receiver. The whole must be allowed to operate spontaneously without heat for twelve hours. At the end of this time the retort is to be surrounded with a water bath and steadily heated during twelve hours, and then left to cool for six hours. The apparatus must now be opened, the cakes of chlorate of potash removed, and freed from muriate by solution and crystallization.

M. Liebig proposes the following process for obtaining chlorate of potash:—

Heat chloride of lime in water till it ceases to destroy vegetable colors. In this case a mixture of chloride of calcium and chlorate of potash is obtained. This is to be dissolved in hot water, and to the solution concentrated by evaporation, chloride of potassium is to be added, and then suffered to cool. After cooling, a quantity of crystals of chlorate of potash is obtained, which are to be redissolved and crystallized again to purify them. M. Liebig considers that this will be a cheap process for obtaining chlorate of potash. From 12 ounces of chloride of lime, of so bad a quality that it left 65 per cent. of insoluble matter, he obtained an ounce of chlorate of potash.

The only difficulty to overcome in this process is, from the chloride of lime not being so easily decomposed by heat as is generally supposed; a solution of it may be kept boiling for an hour without losing its bleaching power. The best method is to form a thin paste with chloride of lime and water, and then to evaporate to dryness. If it be required to prepare it by passing chlorine into cream of lime, it is advantageous to keep it very hot.

The chlorate of potash which separates from the solution by crystallization, has not the form of scales which it usually posseses, but is prismatic: whether this is occasioned by some admixture has not been ascertained; but on re-crystallizing, it is obtained in the usual form

The solution ought not merely to be left to cool, in order to procure crystals, for the crystallization is far from being terminated even after complete cooling; crystals continue to be deposited for three or four days.

The following modification of the process for making chlorate of potash is that of M. Vée. A solution of chloride of lime marking 18° or 20° Baumé, is to be set upon the fire in a lead or cast iron pot, and when it begins to get hot, there is to be dissolved in it a quantity of chloride of potassium, sufficient to raise the hydrometer 3° or 4°. It must be then concentrated as quickly as possible till it marks 30° or 31°, taking care that it does not boil over by the sudden extrication of oxygen. The concentrated liquor is set aside to crystallize in a cool place; where a deposit of chlorate of potash forms, mixed with chloride of potassium. The mother waters being evaporated to the density of 36°, afford another crop of crystals, after which they may be thrown away.

The salts obtained at the first crystallization are to be re-dissolved, and the solution being brought to 15° or 16° is to be filtered, when it will afford upon cooling pure chlorate of potash.

Chlorate or oxymuriate of potash has a cooling, somewhat unpleasant and nitrous taste. It does not bleach. At 60° F. 100 parts of water dissolve six parts of it, and at its boiling point or 220°, sixty parts. When heated to dull ignition in a glass retort it gives out 39·15 per cent. of its weight of oxygen, and becomes thereby chloride of potassium. When strongly triturated in a mortar it crackles, throws out sparks, and becomes luminous. It deflagrates upon red-hot cinders like nitre: when triturated along with sulphur, or phosphorus, it detonates with great violence, not without danger to the hands of the operator, if they be not protected by a thick glove. Similar detonations may be produced with cinnabar or vermillion, sulphuret of potassium, sugar, volatile oils, &c.; but they can be effected only by the smart blow of a heated hammer and anvil. A mixture of sugar or starch with chlorate of potash is readily inflamed by a drop of sulphuric acid, and this experiment is the basis of the preparation of the oxygenated matches, as they have been commonly called. The following formula forms a good paste for tipping the said matches, made of narrow slips of either wood or card. Thirty parts of the chlorate in fine powder are to be mixed gently with a spatula upon paper with ten parts of flowers of sulphur well levigated, eight of sugar, five of gum arabic, and enough of vermillion to give the whole a rose tint. We begin by mixing tenderly together the sugar, the gum, and the salt previously pulverised: we then add as much water as shall reduce the mixture to a thin paste, and lastly introduce the sulphur; after which all must be well incorporated. The points of the matches, either previously tipped with sulphur or not, are to be dipped in that paste, so as to get coated with a little of it, and are lastly laid in a warm place till they become thoroughly dry. To kindle one of them, it must be touched with strong sulphuric acid, which for this purpose is usually kept in a small well-stoppered phial, and thickened with amianthus. Aspen is reckoned the best wood for matches.

Of late years a detonating priming for fire-arms has been much used with the percussion locks. The simplest formula for making it is to take ten parts of gunpowder, lixiviate it with water, and to mix the residuum, while moist, with five parts and a quarter of chlorate of potash, reduced to an extremely fine powder. The paste may be made pretty thin, for the salt is sparingly soluble in the cold water, and it mixes best when tolerably fluid. This powder when dry is dangerous to handle, being very apt to explode. But this danger is guarded against by letting fall a drop of the paste into each copper percussion cap, and leaving it to dry there. In the detonation of this powder, besides muriate of potash, there are generated a little sulphate of potash and chlorine gas, which rust the metal very fast. For which reason fulminate of mercury is now preferred by many sportsmen as a detonating powder.

NEW PROCESS FOR HARDENING EARTHENWARE AND GLASS.

A discovery has just been made which is likely to lead to important modifications in the manufacture of earthenware and glass. It consists in bringing, by a long exposure to heat, glass vessels of every description to a state of perfect solidity and opaqueness, in which they entirely lose their transparency, and acquire a color of which the shade varies according to the proportions of the matters of which they are composed. The glass once deprived of its alkaline salts by this process, which produces volatilisation, acquires, it is said, remarkable properties, and amongst others that of being proof against breakage, and of passing from the highest to the lowest temperature, and *vice versâ*, without danger. It would appear, from what we have stated, that it is to the salts, fusible and solvent in their nature, which enter into the composition of glass and crystals in general, that their transparency is to be attributed; and that once their evaporation is effected, there remains only a silicious matter, more or less pure, according to the elements that have concurred in their formation. As soon, therefore, as the soda or potash becomes volatilised, it naturally follows that the glass will lose its transparency, and become opaque. The art of glass manufacture will, in our opinion, sooner or later, derive instruction and advantage from the almost insignificant phenomenon that chance seems to have revealed to it, and articles which are required to sustain the action of a high temperature, such as crucibles, fire bricks, and hearths, may also be obtained from it. A patent has been taken out for the discovery.—*Courrier de Lyons*.

THE SUN AS A SOURCE OF HEAT.

The globe which we inhabit, in its physical characters, is in all respects analogous to the smaller bodies which exist on its surface. These bodies, being within the reach of direct experiment, are the means by which, in the first instance, we are enabled to discover the chief properties of matter. Observation of the more distant appearances of the greater masses of the universe, including the earth itself, teaches us that these bodies are playing the same part, on a grander stage, as the most minute particles of dust which dance in the sunbeam, or the still more impalpable atoms of air which float around us. The force of an irresistible body of analogies, therefore, hurries us to the conviction that the same physical properties, which observation and experience disclose to us in the more limited masses which immediately surround us, are exhibited in exactly the same manner among those infinite systems of bodies, which, filling the immensity of space, are placed far beyond the reach of that species of observation by which alone those peculiar qualities can be detected.

Like other physical qualities, the distribution of heat is regulated by the same laws among the bodies of the universe as among the bodies which surround us. The earth radiates and absorbs heat in the same manner as any body placed on its surface. If there were no external source of heat, therefore, the consequence would be that the earth, by constantly dismissing heat by radiation into the surrounding space, would be gradually cooled, and the temperature of all objects would fall indefinitely. Liquids would be converted into solids; and gases into liquids, and subsequently into solids. But although the earth radiates heat, and thereby continually loses a portion of that heat which it contains, it, on the other hand, absorbs such heat as is radiated upon it by other bodies. The bodies of the universe, from which the earth in this manner may receive a supply of heat to replace its loss by radiation, may be expressed in three distinct classes: 1st, the sun; 2d, the other bodies of the solar system, including planets and satellites, and the moon; and 3d, the fixed stars. We have already seen that the heat which accompanies the rays reflected from the moon is inappreciable to the most sensible thermometer; and that, even admitting that the reflection of heat from the moon was proportional with its reflection of light, the utmost effect of its rays, when condensed 300 times by a powerful reflector or lens, would not produce an effect amounting to a minute fraction of a degree of the thermometer. It may, therefore, be assumed, that from the moon the earth receives no sensible supply of heat to replace that which it loses.

The experiments of Professor Leslie on radiation lead to the conclusion that the power of radiated heat from a given object varies with the magnitude of the object and the distance, increasing in the same proportion as the superficial magnitude is increased (the nature of the surface being supposed to be given), and decreasing in the same proportion as the distance is increased. From this conclusion it follows, that the effect of heat radiated from an object is always proportional to the apparent visual magnitude of that object. Thus, if two bodies, radiating heat in a similar manner, have the same apparent magnitude, whatever be their real magnitude, the effect of their radiated heat will be the same.

Assuming that the surfaces of the planets and their satellites have the same power of reflecting heat as the moon, it will follow, that the effects of these bodies in radiating heat to the earth, compared with that of the moon, will be in proportion to their apparent magnitudes. Now, the apparent magnitude of the largest of these bodies is prodigiously less than that of the moon, and many of them have so small an apparent magnitude, as to be invisible to the naked eye. It follows, therefore, if the heat radiated to the earth by the moon be inappreciable, that which proceeds from the planets and other bodies to the solar system will be still more inconsiderable. So far, therefore, as the solar system is concerned, the sun alone must be regarded as the means of restoring to the earth the heat which it loses by radiation.

All the results of astronomical observation countenance the probability that the fixed stars are bodies similar to the sun. They shine with their own light, and not, like the planets, with light received from another object. Their light is, therefore, far more intense and splendid than that of any planet. If it be assumed, that these bodies be similar to the sun, we may suppose that their rays are equally calorific. It will therefore follow, by the law established by Sir John Leslie, that the heating power of the fixed stars will be, to that of the sun, in the proportion of their apparent magnitudes. On a first view of these facts, and considering the intense heating power of the sun's rays, and the immense number of the fixed stars, it might be supposed that the firmament, studded as it is by these bodies, would offer an extensive source of heat. Such, however, is not the fact. The distance even of the nearest fixed stars is so immense, that the most powerful telescope ever yet constructed, has been incapable of producing the slightest effect in magnifying them. In fact, no fixed star has any visual magnitude whatever: they are mere lucid points which subtend no angle to the eye. If, therefore, Leslie's law be applied to them, it will follow that the heat of solar light is, to that of the fixed stars, in an infinite proportion.

NEW MOTIVE POWERS.

A FEW years ago considerable sensation was produced by the appearance of a work, published originally in America, and soon after reprinted in this country, under the title of "Paradise within the reach of all Men," &c., in which the author, Mr. Etzler, undertook to demonstrate the existence of motive powers in nature, which might be so applied as to supersede most of those mechanical and other inventions which society so extensively employs for the satisfying of its numerous wants. Mr. Etzler went further, and declared that he, himself, possessed a knowledge of the means of so applying these powers, and offered, upon very moderate conditions, to make known his discoveries. After retaining these secrets in his own bosom for a number of years, it was Mr. Etzler's fortune to become acquainted with an individual who could appreciate his views, and who introduced them and their author to certain other spirited capitalists. The result has been the formation of a company in the United States, for the purpose of bringing these discoveries before the public. A patent has been obtained in America, and, within the last few days, one for the United Kingdom, in the right of Mr. Stollmeyer, whose visit to Europe is expressly for the object of securing the patent rights in this and other countries; after which, no time will be lost by the patentees in making the promised discoveries known. We may state, too, that an elaborate work, principally descriptive of the new inventions, is already completed by the author of the "Paradise," &c., and will be published as soon as the above objects shall have been accomplished. Through the favor of Mr. Stollmeyer, we have seen the models of Mr. Etzler's inventions, and have been astonished at their simplicity, and their manifest superiority over every application of motive powers now known. We are not permitted to enter into the details of these extraordinary improvements, but shall venture to say that no one, after having seen them, can doubt the possibility of the results predicted in Mr. Etzler's highly original work. The patents are for "certain improvements in the application of the powers of wind and water to agricultural and other purposes." One of these purposes is the propulsion of vessels on the ocean. The anticipated results of the new application of these powers on land are of quite as superior and decided character.—*Inventor's Advocate.*

THE CAST-IRON LIGHTHOUSE.

IN writing a description of a cast-iron lighthouse tower just completed for the island of Jamaica, an opportunity is afforded for a few words on the advantages offered by this peculiar mode of construction. Mariners have frequently been deprived of the security afforded by lighthouses on dangerous coasts, from the great costliness of such structures, as well as from the danger or difficulty attending their erection, in consequence of local peculiarities arising either from tidal restrictions, or from the difficulty of obtaining foundations of sufficient solidity to support the heavy mass of masonry of the tower. It is a fact of common occurrence that years are required to erect a lighthouse of very moderate dimensions, where the rate of working is limited, both by the nature of the tides and by the peculiarity of the season; and the authorities who preside over these matters are frequently deterred from entertaining the application, for such facilities to navigation, from the cost and trouble attending their execution.

The situation for which the lighthouse is intended, has long required this protection, but the great expense of stone or brick erection, and the time required to complete them, have interfered with their earlier execution to complete the plan.

Mr. Alexander Gordon, the engineer to the commissioners appointed to carry the plan into effect, is the designer of this building, and who recommended the adoption of cast-iron, in consequence of the suggestions some years ago of Capt. Sir Samuel Browne, and the subsequent erection of a small light tower on Gravesend Pier, by Mr. Clarke.

The advantages which iron, when not in contact with sea-water, possesses over stone or other materials, is, that upon a given base a much larger internal capacity for dwellings and stories can be obtained with equal stability. The nature of the material admitting of the plates being cast in large surfaces, there are fewer joints, and consequently greater solidity. A system of bonding the plates may also be adopted, which will ensure the perfect combination of every part, so as to form one entire mass, and by the facility which such a plan offers for uniting the parts, the best form for strength and stability can be obtained. The time required for the construction of such a building in iron being less than that required for the preparation of one of stone, would, in many instances, influence its adoption, and from the comparatively small bulk and weight of the component parts of the structure, much greater facilities are afforded for transporting and erecting it at its destination. It is a fact worthy of remark, that in less than three months from the date of the contract, the lighthouse in question was cast and erected on the contractor's premises, and it is the intention of Mr. Gordon, the engineer, to have the light exhibited in Jamaica, on January 1st, 1842, being six months from the date of its commencement. This is a degree of expedition commensurate with the extraordinary despatch of the present day, when all operations, however great and difficult, seem to advance with a celerity which a few years back would have been deemed chimerical.

The expenses of the construction, the transmission to its destination, and its final erection, will not exceed one-third the cost of a stone building of equal dimensions and capabilities; and in localities where the materials are not naturally produced, but have to be transported from a distance in a fit state of immediate erection, the expense would considerably exceed this ratio. Another prominent feature in the construction of iron lighthouses, &c., is the security from electric influence, the material itself being one of the best conductors of the electric fluid, and if proper means be taken to transfer the electric fluid from the base of the tower to the sea by means of copper conductors, no danger need be apprehended from its effects.

The lighthouse in question is the first of its kind that has been practically carried out, and from its having to withstand the destructive hurricanes which, as well as the frequent earthquakes that occur in the West Indies, it will afford a good example for future practice. The form has been selected as well for strength as for symmetry, and the arrangement of the lantern and light apparatus reflects the greatest credit on the manufacturer, Mr. Deville.

The tower is to be founded on a coral rock, a little above the level of the sea, the face of which rock is about 10 feet beneath the surface of the sand, and which will be excavated to receive the base of the tower, resting on and cased with granite, to prevent the natural filtration of the sea water from acting upon the iron. The course of granite upon which the base of the tower rests, is grooved to receive the flange of the lowest plates, from which the lightning conductors are continued to the sea. The diameter of the tower shaft is 18 ft. 6 in. at its base, diminishing to 11 feet under the cap; it is formed of nine tiers of plates, each 10 feet in height, varying from 1 to ¾ inch thickness. The circumference is formed of 11 plates at the base, and 9 at the top; they are cast with a flange all round the inner edges, and when put together, these flanges form the joints which are fastened together with nut and screw bolts, and caulked with iron cement. The cap consists of 10 radiating plates which form the floor of the light room, and secured to the tower upon 20 pierced brackets, being finished by a light iron railing. The lower portion, namely 27 feet, is filled up with masonry and concrete, weighing about 300 tons, and so connected with the rock itself that it forms a solid core of resistance; the remaining portion of the building is divided into rooms which are to be appropriated as store rooms and berths for the attendants in the lighthouse.

The light room consists of cast iron plates five feet high, on which are fixed the metal sash bars for receiving the plate glass, these terminating in a point are covered with a copper roof, from which rises a short lightning rod, treble gilt at the point, to attract the electric current.

The light is of the revolving kind, consisting of 15 Argand lamps and reflectors, five in each side of an equilateral triangle, and so placed as to constitute a continuous light, but with periodical flashes.

In order to preserve as low a temperature as the nature of the circumstances and climate will permit, the iron shell is to be lined with a non-conducting material, such as slate or wood, leaving an annular interstice, through which a constant ventilation will be effected, and by which the excessive heat will be carried off, in which it will doubtless be assisted by the evaporation of the sea spray which may accidentally be cast upon it, as it will be placed within 60 yards of the ordinary water level.

In order to preserve the two lower tiers from oxidation, they have been coated with coal tar, and Mr. Gordon intends to set them in the granite with a bituminous cement. The only bracing which has been thought requisite is a few cross ties at each horizontal joint, over which the iron tongued wood floors are laid.

The several rooms are provided with five apertures, fitted with oak sashes glazed with plate glass; the approach to the doorway, which is about 10 feet above the level of the sand, will be by means of stone steps; ladder irons are also provided in the event of the stone steps being carried away by a hurricane.

The whole of the castings were executed by Mr. Robinson, at his manufactory (late Bramah and Robinson), at Pimlico, and put together in the yard of the manufactory prior to their removal for its intended destination.

The work will be re-erected in Jamaica by means of a derrick and crab from the inside, without the aid of any external scaffolding.

We understand that the whole expense of the lighthouse, including the passage over the Atlantic, and the erecting it on the promontory in Jamaica, will not exceed £7000, and that the entire weight of iron of the whole fabric is about 100 tons. The masonry is being prepared in this country, as it will be more economical to send it from England than it will be to get the stone and work it in Jamaica. Three mechanics are also to be sent out with the work to put it together on its destined spot.—*Civil Engineer.*

PHENOMENA OF GLASS.

(To the Editor.)

SIR,—Having read with much pleasure an article, in your truly valuable work, upon the "Phenomena of Glass"; and being much struck with the wonderful and seemingly unaccountable mystery attending the fracture of the tube, and Rupert's drop; I have taken the liberty of hazarding a conjecture as to the cause of the phenomena described.—First: the tube;—It would appear that the tube was cleaned with an iron wire, having a piece of wash leather at the end. Now I would ask of you; is it not possible, that the friction of the leather upon the glass may have the effect of charging the tube with electricity, to such an extent, that, upon the wire coming into contact with it, it acts as a discharge; the shock causing a number of minute fractures in the glass, which every vibration of the air would have the effect of enlarging, until at last it falls to pieces.

As to the fracture of the rod, my idea is this,—The glass in a melted state when dropped into cold water, by its great heat decomposes it, and at the same time immediately contracting it, forms into a drop, inclosing a mixture of oxygen and hydrogen: derived from the water. Supposing this to be the case, (on striking two pieces of glass together in the dark, a spark will be plainly seen,) may not the sudden breaking off of the end, be sufficient to cause a small spark, enough to ignite the gas contained within, when an explosion would take place, of sufficient force to break the glass into pieces, at the same time it would give a shock to the hand.

These being the ideas of a very young beginner in chemistry, I hope you will excuse all errors.

OXYGEN.

MEMORANDA.

New Metallic Substance.—At a recent sitting of the French Academy of Sciences, M. Peligot submitted a paper on a new analysis of the substance called by French chemists "Urane," which had been hitherto ranged among the simple metals; he had found that it was not a simple substance, but was a compound or oxide of uranium, and that the true metallic base was capable of being separated from the compound substance. M. Peligot had acted by means of chlorine and potassium, and, having obtained the new metallic substance, which had never before been got pure, had found its atomic weight to be expressed by the tabular number of 750.

Valuable Discovery.—Recently, two intelligent French mechanics attended at the plumbers' shop in the Woolwich Dockyard, to show the workmen and a foreman from each of Her Majesty's other dockyards, a new invention for soldering or joining metals without solder. The mode of operation was discovered by Le Comte de Richemond, who has taken out a patent for it in this country. The invention is applicable to brass, copper, lead, pewter, and zinc, and the process is very simple. It merely consists of the application of a very powerful heat from a small tube, exactly similar to a blow-pipe, attached to a pliable hollow thong, woven similar to a whip, but made air tight, at the end of which is placed two stop cocks, the one to admit hydrogen gas, generated on the spot, by placing sulphuric acid mixed with water upon cuttings of zinc in a vessel constructed for the purpose. The other stop cock admits atmospheric air in any quantity and with great force when requisite, as it is assisted by a small portable bellows worked with the foot upon a pedal similar to those used by the glass-blowers at the Polytechnic Institution and Adelaide Gallery. The foremen of the various yards tried a number of experiments with lead, both with flat and round pieces, and formed joints, all of which they performed in a very satisfactory manner, and appeared at once to comprehend the whole theory of the discovery. The joining cannot be known from any other part of the metal, and must be a great advantage over the old method, as it passed through the whole thickness of the metal, and appears to be as perfect on the one side as the other, enabling every part to bear equal pressure.

Application of Glass Tubes as Water-Pipes.—The *Journal St. Etienne* states that experiments were to be made on the 2nd of this month of a plan proposed by Messrs. Bergeron and Cambier, civil engineers, for the employment of glass instead of cast-metal pipes for the supply of the principal fountain of *Rive de Gier*. The advantages of glass pipes may be easily appreciated; the water will leave the fountain in the same state in which it entered it, without being altered in its nature, or stopped in the pipes, by the effects of oxidation or of corrosions, which often obstruct metal pipes. Every one knows that glass can be submitted to enormous pressure, without danger of breaking. We have seen, for instance, bottles of champagne support a weight of 40 atmospheres without injury. The proposed pipes then, 18 centimetres in diameter, ought to resist easily a pressure of six atmospheres. Should the experiment succeed, its effect will be to reduce to one-third of their present price the cost of water-pipes.—*Le Fanal.*

Fresco Painting.—A correspondent of the *Athenæum* suggests the following substitute for fresco painting in the decoration of the New Houses of Parliament, which he contends will have an equally beautiful effect and be quite as durable. "The wall is first covered with Roman cement, commonly called stucco; after this is dry, it must receive three or four coats of a mixture of fat linseed oil boiled with gum, similar to varnish—in fact, it may be called varnish, only observing that it will not crack. This penetrates the cement, and keeps it from what is termed sweating. Then cover with the ground for the picture, preparing the color with half turpentine. For the picture itself, have your colors ground in oil and work them in turpentine, and it will have the same effect as fresco painting. It requires to be finished expeditiously, as the colors set fast. This sort of painting, I should say, would answer well: 1st. Because it will dry hard. 2nd. It will retain its color. 3rd. It is equal to fresco in beauty and appearance. 4th. After preparing the walls, the rooms may be used for business, and the artists continue their labours at such times as are most convenient, as there is but little or no dirt. Any artist will be able to execute works in this style."

Fire and Water Proof Cement.—Pour a pint of vinegar into a pint of milk; when the latter has fully coagulated, clear it off the lumps, and let it settle, then mix the whole well together; now sift into the liquid quick lime, till upon stirring the whole we obtain a thick paste. This cement will permanently unite marble, earthenware, china, &c. —*French paper.*

Temperature of Plants.—Mr. Van Beck has constantly observed this phenomenon, in the course of his experiments—that in suddenly raising the bell-glass which cut off all communication between the air of the apartment and that of the plant, the heat of the latter always rose suddenly some tenths of a degree. This phenomenon, however, lasted only a few minutes: the magnetic needle soon retrograded, passing zero of the scale, and showing, by its opposite and permanent duration, that the living plant had a much lower temperature than the dead leaf, as is always the case in the atmosphere. Is this phenomenon to be ascribed to the instantaneous access of free air to the plant, which, by stimulating its vital functions, that were depressed by its having been kept in a less pure air, augments at the same time its proper heat, *before the counteracting and frigoric influence of re-established evaporation has had time to make itself felt?* M. Van Beck cannot venture to decide this: but he hopes that other philosophers and naturalists will engage in these researches, which, if he is not deceived, may yet throw some light upon many an interesting question in animal physiology.—*Compte-Rendu.*

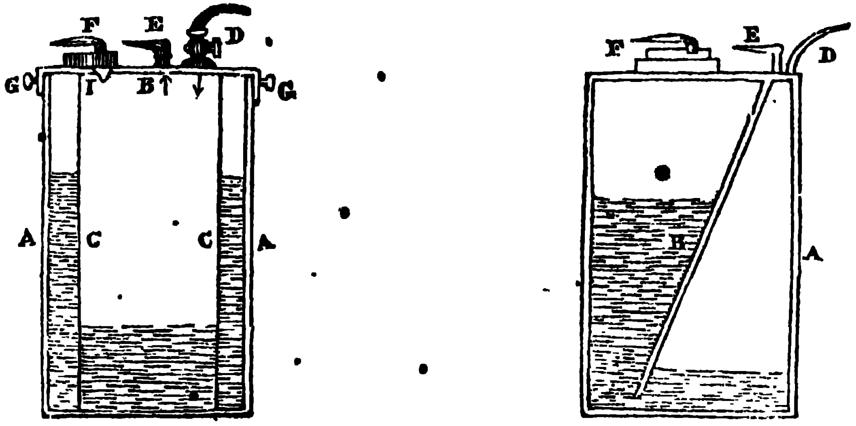
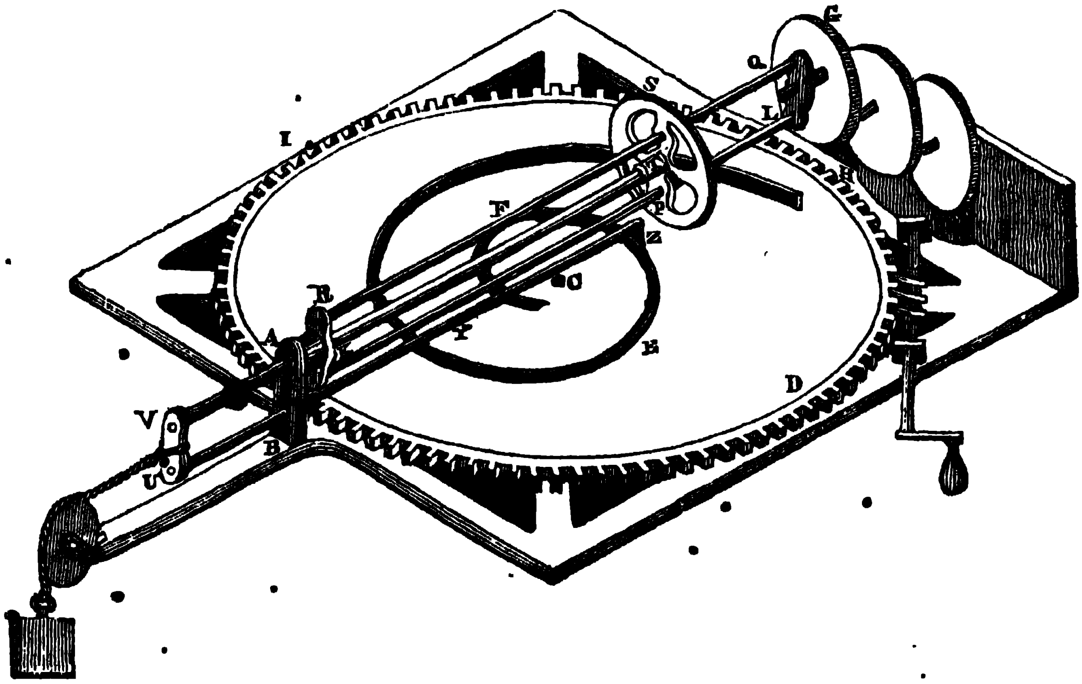


Fig. 1. *Fig.* 2.

SHARPIN'S AND TILLEY'S BLOW-PIPES.



MOSELEY'S CALCULATING MACHINE.

CHEAP HYDRAULIC BLOW-PIPE.

(To the Editor.)

SIR,—I inclose for insertion in your Magazine, a sectional drawing of a simple, cheap, and effective hydraulic blow-pipe. The description is as follows: A, Fig. 1, is a cylindrical tin vessel, 13 inches deep, and 10 inches in diameter. B is a loose lid, to which is soldered air-tight the vessel C, which is 6½ inches in diameter, but without a bottom, and approaches to within a quarter of an inch of the bottom of the former vessel A. D is a piece of ½ inch lead-pipe, with a tap at the lower end, which communicates with the interior of the vessel C; E is a piece of ½ inch pipe, which also communicates with the vessel C; F is the lamp; G G is two pins of wire, to prevent the lid from being lifted up by the pressure of the water when in action; I is a lip which must be left uncovered, so as to allow the air free access to betwixt the vessels A and B.

To use the blow-pipe, take off the lid and nearly half fill the vessel A with water; then put on the lid, and fasten it down by the wire pins G G. Put a glass nozzle on the pipe E; open the tap, and blow down the pipe D, so as to force all the water out of the vessel C. Then shut the tap, and you will have a steady stream of air for about three minutes, providing the orifice in the glass nozzle be not too large.

A blow-pipe upon this plan will be found very useful in every little laboratory for many purposes; by merely taking off the lid it forms an excellent vessel for holding water; it may also be converted into a pneumatic trough, by soldering three small tin brackets, about 3½ inches from the top of the vessel A, so as to support a moveable tin shelf.

H. SHARPIN.

[The above is so very similar to the hydraulic blow-pipe of Mr. Tilley, that we have subjoined a cut of the latter instrument, Fig. 2, also. A is the outer vessel which is square; B a division across; D E F the same as in Mr. Sharpin's instrument.—ED.]

ON A MACHINE FOR CALCULATING THE NUMERICAL VALUES OF DEFINITE INTEGRALS.

BY PROFESSOR MOSELEY.

IT is the object of this machine to apply to the numerical calculation of definite integrals, a principle first suggested by M. Poncelet for the registration of dynamometrical admeasurements, which has been applied by M. Morin to an instrument called the compteur, for registering the traction of loaded carriages upon common roads, and during the last year by a committee of the British Association, to a permanent registration of the work of the steam upon the piston of a steam-engine. The machine about to be described has some mechanical expedients in common with the last-mentioned machine; it has nothing in common with the compteur of M. Morin, except the admirable principle of M. Poncelet. In the accompanying figure, D E represents a circular disc, moveable about an axis C, passing through its centre by means of an endless screw, working in teeth, cut upon its circumference. Q R K L is a rigid frame, composed of two rods, Q R and L K, joined by cross-pieces, Q L and R K, and moveable at its extremities about axes whose centres are in a straight line, passing through the centre C of the disc. The axis A of this frame is *hollow*, and there passes through it a rod V T, at the extremity of which is a wheel S P, which, from the peculiar functions assigned to it in this machine, is called the *integrating* wheel; the wheel is moveable about the extremity of the rod V T, but is confined to it by means of a nut, and it has holes in two of its arms, through which the rods Q R and L K of the frame pass, fitting them accurately. The axes of the frame turn in bearings, which are not fixtures to the frame of the instrument, but which slide vertically by means of grooves in the fixed pieces A B and G H. The weight of the frame and of the wheel S P is thus made to rest entirely upon the point of contact P of the edge of the wheel with the disc D E, and any amount of friction of the two surfaces of contact may be obtained by sufficiently loading the frame. The rod T V is connected by means of a vertical piece V U, with a second similar rod U Z, at whose extremity Z is a short vertical piece reaching to the surface of the disc, and kept pressed against the curved edge or rail E F (which is screwed down upon the plate, and is of any given geometrical form), by means of a cord attached to the cross-piece V U, and carrying a weight. It is evident from this construction that, if the curve E F be any other than a circle, having its centre in C, the wheel S P will be made to *alter* its position on the frame Q R, and the point P its distance from the centre C, by the pressure of the edge E F, when the disc or plate E D is made to revolve by the action of the screw; and that the geometrical law of this change of position, in reference to any angular revolution of the disc, will be dependent upon the polar equation of the curve E F, or upon the relation of its radius vector C Z, to the angle which that line makes with any other similar line given in position in it. Now let it be conceived that such a form is given to the curved edge E F, as to cause the distance C P of the point of contact P, of the circumference of the wheel S P, from the centre of the disc, which distance differs very little from C Z, to be a given function F (θ) of the angle θ described by the disc E D, and let it be observed that, as the wheel S P is made to traverse the frame Q R, by the pressure of the edge or rail E F; this wheel is also made to revolve by its friction upon the plate at P, that friction being produced by the pressure of the weight of the wheel and of the frame Q R upon the plate; which pressure, if it be not sufficient for the purpose, may be increased in any proportion. The wheel S P thus continually varying its distance from the centre C of the plate, and its circumference continually revolving with the velocity of that part of the circumference of the plate with which it is then in contact, it follows that the number of revolutions, and parts of a revolution, which is made by it, and therefore by the frame Q R, which it carries with it, as the plate revolves from any given angular position θ_1, to any other, θ_2, is a function of the form and dimensions of the curve E F.

Let now a contrivance be applied to the instrument for registering the revolutions N of the frame Q R K L, and therefore of the integrating wheel S P, to the 1,000th part, or to four places of decimals. This registration may be made by the common method of astronomical instruments; or more conveniently, and perhaps with sufficient accuracy, by means of a toothed wheel fixed on the axis of the frame, and running into a pinion in the proportion of 10 to 1; this pinion carrying a wheel which runs into a second pinion in the same proportion, and so on through a train of wheels and pinions, each *wheel* of which being divided into 10 equal parts, and numbered, will show one digit of the decimal part of a revolution up to as many places of decimals as there are *wheels*. The complete revolutions of the frame may in like manner be registered by means of a pinion on the axis of the frame running into a *wheel* in the proportion of 1 to 10. The value of N may thus be registered to four places of decimals probably with *accuracy*.

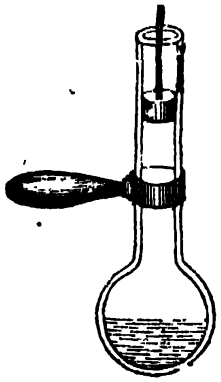
And if, connected with the endless screw which gives motion to the plate, there be a train of wheels registering the space described by a point in the plate, at distance unity from its centre to three or four places of decimals, and the plate be made to revolve from the position in which the given radius vector coincides with C P into a position in which the index of the first register shows any No. N, then will the second or last-mentioned register show the logarithm θ_1 of a number one greater than that. So that by this adjustment of the apparatus, it may be made to replace a table of ordinary logarithms. It would be better, however, with a view to this application of it, to replace the plane disc D E, by the surface of a cone. The requisite spiral would more readily be traced on the surface of such a cone; it is identical with the *natural spiral*, traced out by the convolutions of a large class of turbinated shells. Under this form the instrument might be brought into a comparatively small compass; and it is not difficult to see that by a mechanical combination of no great complexity, it might be made to add or to subtract the logarithms which it registers, and to record the *numbers* which correspond to the logarithmic sums or differences, which it thus *obtains*, completing in this process the mechanical operations of multiplication and division in respect to numbers of any number of digits. The only examples hitherto given of the calculation of this machine, are examples which lie within the compass of the ordinary methods of analysis; and, in respect to these, the instrument could only serve to *replace*, perhaps conveniently, but still less *accurately*, well known processes of analytical calculation or tables already formed. There is, however, a large class of functions, whose analytical integration lies beyond the existing resources of mathematical science, the *mechanical integration* of which this machine will nevertheless readily effect. The accuracy of the results it gives in respect to these, being dependent upon the same principles as the accuracy of the results it gives in respect to the others, and, therefore, verified by a comparison of these last results with the tables. It is impossible, in this popular and hasty discussion of the subject, to enter at any length, or with any system or method, on the consideration of this class of integrals, and the resources of mechanical integration, which the machine offers in respect to them.

Among the mechanical difficulties which present themselves to the construction of such a machine are the following:—Great accuracy will be required in giving their true geometrical forms to the curves fixed upon the revolving plate. It is unquestionable that a certain amount of error must always remain due to inaccuracies of workmanship in the forms of these curves; nevertheless to those who are acquainted with the wonderful education of the sense of touch and the skill of hand acquired in the minute workmanship of some processes of the arts (the engraving of type-founders' dies for instance, or the drawing of micrometrical lines on glass, many of the camb movements of machinery, and the admirable tools of Mr. Whitworth), it will not appear impossible to reach, with the requisite care and patience, a very considerable degree of precision in this respect; and let it be remembered, that one type or model being thus attained, it may be reproduced infinitely, and with perfect accuracy, by casting in type-founders' metal, or perhaps by turning, or by the electrotype. Again, the difficulty of constructing these curves will, no doubt, in some degree be enhanced by the fact, that the guiding curve E F must be different from what it would be if the points Z and P coincided. This difficulty (not in itself considerable) may, however, wholly be removed. We have only to take the curves from the plate D E, and to place them on another circular plate parallel to and concentric with D E, of precisely the same dimensions, but so far above it as to clear the integrating wheel S P; and then to give to the connecting piece V U a direction upwards instead of downwards, so that the bar U Y Z may pass to the superior surface of the upper plate; if this bar be then precisely of the length of the arm V T, the point P will be made to describe a path on the lower plate precisely similar to that of the point Z on the upper. And let it here be observed, that there are some important applications of the instrument, in which the curve E F admitting of an easy mechanical description, the guidance of a rail may be entirely dispensed with, the point Z being made to vary its position according to the required law, by some more convenient or more accurate mechanical expedient. In conclusion, let it be observed, that since by milling the edge of the integrating wheel S P, by making the plate D E of a soft metal —brass, for instance, or perhaps zinc—and by loading the frame, any degree of friction of the surfaces at P may be obtained; and by increasing the diameter of the wheel S P, any leverage of that friction to turn the machinery connected with the frame, it would be quite practicable to introduce those mechanical expedients into the train of wheels which are necessary to cause the digits of the numbers registered to arrange themselves *side by side* in a line; and that then, by uniting with it the admirable combinations of Mr. Cowper's printing press, the machine *might* be made to *print off* the results of its calculations, precisely as by the same press the successive numbers are made to print themselves upon bank notes.

STEAM AND THE STEAM ENGINE.

We now commence a series of papers on the history of the steam engine, intending in the course of them to give representations and descriptions of all the celebrated engines, which have, from time to time, been invented. To understand this difficult subject the more readily, and to prevent as much as possible interruptions in the course of our intended review, we have thought it advisable to offer the following remarks on the nature of *steam* itself, as a preliminary knowledge necessary to be constantly borne in mind, whether in appreciating the contrivances of different inventors, in understanding the peculiarities of each, or in applying the fundamental principles of science and experiment to their legitimate and useful applications.

When water, exposed to the pressure of the atmosphere, is heated to the temperature of 212°, globules of steam, composed of heat and water in a state of combustion, are formed at the bottom of the vessel, and rising through the fluid may be collected at the surface. In its perfect state it is transparent, and consequently invisible, but when it has been deprived of a part of its heat by coming into contact with cold air, it becomes of a cloudy appearance, as when it issues from a tea kettle. While remaining in an open vessel, by increasing the fire, the temperature of the water never rises above 212°, nor that of the steam which is generated; the only effect being a more copious production. If the water be confined, both it and the steam which is produced may be brought to any temperature, and the steam being accumulated, will eventually, if the fire be continued, inevitably burst the vessel containing it, however strong the latter may be. Steam is highly elastic, but when separated from the fluid from which it is generated, it does not possess a greater elastic force than the same quantity of air. If a small quantity of air be inclosed in a thin vessel, (a bladder for instance,) the neck of the bladder tied tightly, and then it be held towards the fire, the air will expand so much as completely to fill the bladder, and in all probability burst it. This is an universal principle, and steam possesses the property of expansion by heat, no less than other bodies, yet it does not possess it in any extraordinary degree; and it is not to this cause that we are to attribute the singular effects which it presents to us. In fact, this universal principle of expansion by heat is not called into exercise in the steam engine, or merged into the great question of quantity, but rather the elasticity produced by a great accumulation of the steam in any vessel. Thus if a vessel contain water, as well as steam, each additional quantity of heat causes a fresh quantity of steam to rise, which adds its elastic force to that already generated, till the constantly-accumulating power bursts the vessel to pieces. The elasticity of vapour raised from a boiling liquid is equal to the pressure under which it is produced. Thus steam raised from water at 212°, and therefore under a pressure of 15 lb. on the square inch, is endowed with an elastic force which would exert a pressure on the sides of any vessel which confines it, also equal to 15 lbs. on the square inch; and as this vessel is pressed by the atmosphere externally, with an equal pressure, these two forces counterbalance each other, and the vessel has no tendency to collapse or to explode; but if the steam be suffered to cool below 212°, it would be converted into water, and in this liquid state occupy a space 1728 times less than it did as steam; a vacuum would therefore be formed within the vessel on account of the condensation. The atmosphere pressing upon the outside, as before, and having nothing to counteract its force, the sides of the vessel would, if not very strong, immediately collapse. On the other hand, supposing the heat of the water to be increased, steam would be further generated, and its elasticity be so far augmented as to exceed the external pressure, until the vessel would burst, sooner or later, in proportion to its strength. The increased pressure of the steam inferring an increased temperature, for it has been before observed, that it is under the pressure of the atmosphere only that water boils at 212° of heat; but if it have a pressure of accumulated steam above it, it will not boil until arrived at a greater heat. It follows, therefore, that the temperature and pressure are dependent upon each other, and knowing one of these, the other can be easily ascertained. It is this principle which is always to be borne in mind when treating of the steam engine, and calculating its working power; and Dr. Wollaston has illustrated it in a very pleasing and instructive manner, by means of the following apparatus, which is merely a glass flask, with a handle to it, and a piston withinside:—

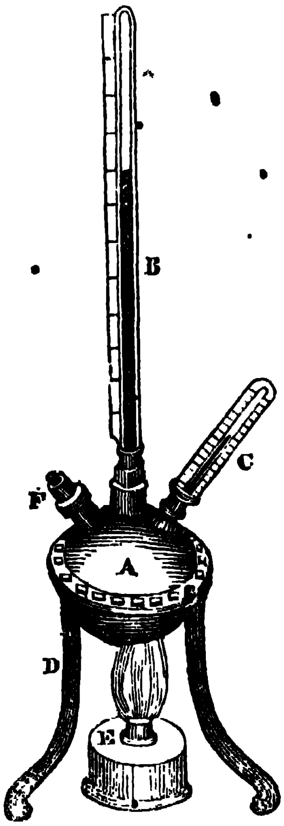


If a spoonful of ether or a little water be placed in the bulb of the flask, and the bulb held over a flame, the contained liquid will soon boil, and consequently throw up steam. Remove the flask from the heat, and insert the piston, when it will be found that, as the steam condenses, the piston will slide down the tube, acted upon by the external pressure of the atmosphere. If now the flask be held over the flame a second time, steam will again be formed, and its elasticity will increase, until first it will acquire the same pressure as the atmosphere, when the piston will remain stationary; afterwards the internal pressure will become so great as to drive up the piston. Now suppose the area of the cross section of the piston to be exactly 1 inch, the pressure of the atmosphere upon it would be 15 lbs. If the pressure of the steam withinside be also 15 lbs., it would be said to have a pressure of *one atmosphere;* if 30 lbs. a pressure of *two atmospheres;* and so on for greater amounts. It is by no means necessary to have an apparatus to ascertain the amount of pressure at all times; for, as it has been before observed, this is dependent upon the temperature of the water in the boiler, each augmentation of heat producing an increase of force, according to the following table:—

Steam at		Atmosphere.
212°	Fahr. exerts a force of ..	1
240°	,, ,, ..	[illegible]
250°	,, ,, ..	2·00
260°	,, ,, ..	2·35
270°	,, ,, ..	2·74
280°	,, ,, ..	3·25
290°	,, ,, ..	3·87
300°	,, ,, ..	4·60
310°	,, ,, ..	5·50
320°	,, ,, ..	6·40

Steam of the same elastic force as the atmospheric pressure is called *low pressure steam,* no pressure above that of the atmosphere being necessary to produce it. Steam of only a few pounds pressure upon the inch above this, (say 5 or 6,) is also called low pressure steam, but of a greater elasticity than this it is called *high pressure steam.*

A very neat apparatus, called the *high pressure boiler*, shows in a very lucid manner the properties of steam when under more than ordinary pressure. A is a strong brass globe or boiler, filled partly with water. B is a long and strong glass tube, open at the top, passing air-tight into the upper part of the boiler, and extending to within a very short distance of the bottom of it. There is a scale to indicate the pressure in atmospheres behind it. C is a thermometer, the bulb of which is withinside A. F is a cock or pipe, to suffer the steam to escape when required. D is a stand for the boiler, and E a spirit lamp. When the water at A is made to boil, its temperature, and that of the steam above it, is increased, as is indicated by the thermometer. At the same time the pressure of the steam upon the water drives it up the tube B, the end of which dips below the surface of the water in A. The height to which the water driven up B rises, and consequently its pressure, will be shown by the scale behind.



(To be continued.)

THE COTTON PLANT.

(Resumed from page 231, and concluded.)

THE shrub which grows wild in many parts of the West Indies, especially in low and marshy grounds, has a rough black seed. The cotton of this is in color a pale red, and is of so short a fibre that it cannot be spun; in consequence, it is scarcely worth the trouble of gathering, and what little is picked up is used for stuffing mattresses and pillows. Among other varieties, the Brazil and the Guiana cottons bear the same kind of seed as the wild species, differing slightly in shape; these are both nearly alike as to the quality of their produce. The Guiana is, after the "Sea Island cotton," the most esteemed in Europe, on account of its color and fineness, and the length and strength of its staple and fibre; it is likewise extremely productive, as it furnishes two gatherings in the year. It is farther valuable as the seeds of this kind conglomerate, or adhere firmly to each other in the pod, and are easily separated from the cotton. This variety requires a moist soil, such as generally predominates in Dutch Guiana.

The Indian corn has a dark brown seed, streaked with black; this cotton is very white and finer than that of Guiana, but not so productive. Six other varieties bear nearly the same description of seed, among which is the Siam so noted in the West Indies, as being nearly equal to silk in beauty and fineness. It is of a brilliant whiteness, and its fibres are very fine, long, and elastic. This variety produces twice in the year, but does not bear a great quantity. It is not much cultivated, because it cannot be cleansed without extreme difficulty: the seed being entirely covered with a kind of green moss or hair, cannot be separated from the cotton by any machine, and not even by the hand without much labour and care.

The cotton of Curaçoa and that of St. Domingo have small seeds, the surface of which is thinly covered with a few short hairs or a thin beard. This kind is of a very tolerable quality.

The seeds of the Jamaica cotton are perfectly smooth, but so brittle as to break in the process of separating them from their downy envelope. The fibre is coarse but strong, and this would be considered of a very useful quality if it could be better cleansed. Little or scarcely any cotton is at present grown in Jamaica compared to the quantity which was produced there a few years back; but it was always considered as one of the worst cottons in the English market, in consequence of the planters persisting in the cultivation of a species which could not, without hand labour, be properly divested of its seed; it was always exported mixed with pieces of these, and was therefore known by the technical term *foul* cotton.

Of all the species of cotton the annual herbaceous plant yields the most valuable produce. The "Sea Island cotton," imported into England from Georgia, bears a price double to that imported from any other country. The Persian cotton has long been celebrated for its superior quality, and the concurrent testimonies of many travellers show, that where this species is cultivated in other parts of the globe it is equally excellent. But the additional labour and consequent expense attendant on its cultivation, as well as its not being equally adapted to all soils, afford perhaps sufficient reasons why it is not more generally adopted. This species is cultivated in China, but not in sufficient quantities for the home consumption, as they import this article largely from India.

The quantity of cotton which each plant yields is as various as its quality. Accordingly, there are scarcely two concurrent opinions to be collected on this subject. The average produce per English acre is reckoned by different writers at various quantities, varying from one hundred and fifty to two hundred and seventy pounds of picked cotton.

The cotton-plant will grow in most situations and soils, and is cultivated with very little trouble or expense.[*] According to Humboldt, the larger species, which attain to the magnitude of trees, require a mean annual temperature of 68° Fahr.; the shrubby kind may be cultivated with success under a mean temperature of 60° to 64°, and may therefore be propagated as far as latitude 40° This plant is indeed cultivated in the neighbourhood of Astracan, the latitude of which is 46°. Some species flourish best in the neighbourhood of the sea; others again are injured by this proximity. The Pernambuco cotton, which is the finest in Brazil, is of the latter kind, and the planters find that in proportion as they recede from the coast the quality of the cotton is improved; they are, in consequence, every year penetrating more into the interior, and they always obtain a ready market for their produce, as the dealers follow their footsteps and settle where they settle.

Open situations and a strong soil moderately dry and warm are most congenial to some species, while others thrive better in a moist and deep soil.

In selecting seed for a plantation, therefore, care should be used to adapt it to the soil and situation in which it is to be cultivated. Previously to sowing them, the seeds should be wholly divested of every particle of cotton fibre, and then steeped in water during some hours; they are afterwards rolled in sand or any light earth, in order entirely to separate them from each other. This process is considered very much to accelerate their germination. The time for sowing in the West Indies is usually from May to September, both months inclusive. The ground is well prepared and manured, and then holes are made some inches deep and about three feet apart from each other. Eight or ten seeds are generally dropped in each hole, because some of them are liable to be destroyed by a grub or worm, and others to rot in the ground; besides which, a superfluity of plants is required to replace the ravages which are sometimes committed by caterpillars on the tender shoots. The seeds being covered with earth, it is generally expected, and especially if there have been any rain to hasten the germination, that the plants will begin to make their appearance in about eight days. In some situations, when the weather has been very dry, a much longer time elapses. At about the end of six weeks the ground is carefully weeded, and those plants which are the weakest are drawn out, only two or three being left in each hole. When the plants are about three or four months old, they are again cleaned and thinned, and the stems and branches are pruned, or, as it is called, *topped*—an inch, or more, of the plants being broken off from the end of each shoot. This is done to retard the growth in height, and to facilitate the development of the lateral branches. Some of the lower leaves are occasionally taken off. These cares should be continued, occasionally, till the period of flowering. The time of the seeds coming to maturity varies according to the climate and the species of the plant. When the season has been favorable, the cotton is generally fit for pulling about seven or eight months after it has been sown. This period is, however, well indicated by the spontaneous bursting of the capsule or seed-pod. The plantations at this time present a very pleasing appearance. The glossy dark green leaves finely contrast with the white globular forms profusely scattered over the plant. In the East the produce is gathered by taking off the whole of the pod. In other parts, and this is the more general practice, the seeds and cotton are taken away, leaving the empty husks. The first is, of course, much the most expeditious method, but it has a very serious disadvantage. The outer part breaks in minute pieces, and thus mixes with the cotton, which cannot be freed from it without much time and difficulty.

Whichever method is pursued, this work is always performed in the morning before sunrise, as soon as possible after the cotton displays itself; because long exposure to the sun injures its color, by giving it a yellow tinge. The pods likewise which are ready for gathering expand in the heat of the day, and in some varieties the seed and its envelope are then detached from the pod, and falling to the ground the cotton becomes soiled and deteriorated. In some countries the plant after yielding its produce is every year cut even with the ground; in others this operation is performed only once in two or three years.

The cotton shrub does not in general last more than five or six years in full or productive bearing; the plantation is therefore generally after that period renewed. The seeds may usually be preserved for one or two years, but in some varieties they should be planted almost as soon as they are gathered. The surplus seeds serve as food for cattle; an oil is likewise expressed from them which is employed for many domestic purposes.

The annual plant is cultivated in the same manner as that just described; only that in sowing it more seeds are put into the holes, and these are placed nearer to each other. It comes to maturity much quicker, the seeds being sown in April or May, and the crop reaped in September; in some hot climates two harvests can be gathered in each year. Another important consideration is, that the cotton should not be pulled immediately after rain, as this would render the drying process much more tedious and difficult; and should it retain any moisture when it is packed, it would ferment or become mouldy. Immediately after gathering it is taken to a barn and assorted according to its quality; it is then laid on mats or hurdles, and exposed to the heat of the sun, or dried in stoves.

ENGRAVING.

(Resumed from page 206.)

THE next process of etching is, what is commonly called, *biting in.* It is more difficult than any which precedes it, and success in this part of the art can only be acquired by practice. The following observations, therefore, however much they may assist the learner, will not, and cannot make him a proficient in this part of the process:—Supposing the etched plate to be prepared as before described: the artist is to take the bordering wax mentioned in page 175, and soak it for a few minutes in *warm* water—it will gradually become soft, and when it is so, a portion is to be taken up by the hands and rolled into a long cylinder, half an inch or more in diameter, and immediately put round the edges of the plate; (of course, being careful that it shall not rest upon any part of the work,) holding the roll of wax in the left hand, which is pressed down to the plate with the thumb and finger of the right hand. This must stand up about half an inch above the surface of the plate, and be pressed down so tightly that when acid is afterwards poured upon the plate, it shall not be able to escape under the wax; also it is advisable to make a lip to this border, to pour off the acid more readily afterwards, when required. This being ready, the artist must have by him some strong nitric acid, to which he may put four or five times as much water; this ought to make it of such a strength that when a drop is placed upon a piece of copper it shall begin to show an action upon the copper in a minute or two, by throwing up small bubbles of gas; if it acts in less time than this, it will be apt to break up the ground around the lines, and make them rough and uneven; if it is not seen to act until a later period, time will unnecessarily be wasted. More water or acid, as the case may require, being added, remedies either of these defects. It will be convenient to pour the acid, when wanted for use, into a cup or basin. Besides the acid, provide a jug of water, a piece of blotting paper, and a quill with the feather on. Now set to work by placing the plate on an exactly flat surface, and pouring into it some of the diluted acid, until it is about a quarter of an inch deep. This will act upon the exposed lines of the copper, and eat them away beneath the surface, forming those lines which are afterwards to be filled with the printing ink. Now the chief difficulty is to know when the plate is sufficiently bitten, that the lines may be neither too pale nor too dark, and the difficulty is increased when some of them are to be of a different shade from others.

We will endeavour to remove some of the difficulty by considering both cases; first,—where the lines are to be all of the same degree of tint. It has been already observed, that bubbles will soon be seen to arise from the exposed copper, when they have come to be of the size of the heads of small pins, or grains of coarse sand: they are to be swept off carefully with the quill. A second crop will arise, and afterwards a third, &c.; these are to be removed in like manner, and when about four or five of such crops of bubbles have arisen, it may be considered that the plate is done enough; the acid is therefore to be poured off, the plate washed by pouring some of the water of the jug upon it, and off again into the jug, and then the plate dried with the blotting paper. Holding the plate up to the light in nearly a horizontal position, the lines will be seen corroded, and an experienced eye can judge immediately by the aspect of them, the result of the biting in, and whether a second application of the acid is necessary or not. Supposing the plate sufficiently etched, the bordering wax is to be taken off and the plate cleaned with spirits of turpentine, rubbed over it with a rag. Then rub over the whole of the plate very slightly with a piece of smooth clean charcoal and oil, in order to take out any burr which may remain upon the lines, and afterwards rub it in the same manner with the oil rubber and oil; this being done, the plate will be ready for the printer. When different gradations of shade are required in the etching, more care and trouble are requisite. In the first place, it is required to bite in the faint lines. This is done by pouring the acid on to the whole plate, but stopping the process earlier than before; the whole plate being thus faintly bitten in, has the acid poured off it, is washed and dried as before recommended, then a little Brunswick black is taken in a brush, and the parts which are to remain thus faint are painted over with it, to preserve them from further action. When the black is dry, which, if good, will be in five minutes, the acid is poured on a second time for the next shade, the operation being again stopped and other lines painted over, or *stopped out*, as it is called; a third application of the acid may be used for those lines intended to be the darkest. The plate is afterwards treated as in the former instance. A third case may occur, in which it is desirable to have a regular gradation of shade from one part or side of a picture to another: to accomplish this, pour the acid over the whole plate, as before, and gradually hold the plate up at one edge, so that the acid may leave the plate bare at that part. Upon raising the plate still higher, the acid will gradually run off, biting the plate as long as it is suffered to remain.

The process of re-biting; of repairing worn-out plates; and correcting false biting, &c., will be treated of in a separate paper.

(*To be continued.*)

VEGETABLE CIRCULATION.

(*To the Editor.*)

SIR.—If the following observations on the vegetable circulation, &c. are worth publicity through the medium of your very valuable, widely-circulating journal, they are at your service:—

There are, at present, three sorts of circulation known to take place in vegetables; these may be divided into general and partial. The general circulation we must allow to be the most important, viz.: that commonly denominated the *circulation of the sap*, (although one circulation is as much that of the sap as any other, as all unelaborated fluids must be included under the term sap.) This commences in the extreme roots or radicles; we can easily imagine endosmosis to be the cause of this, as the sap within the loose cellular tissue of the radicals must be of a greater density than the fluids without; it then passes up the woody tissue and ducts of the root, and entering the stem ascends by the last formed layer wood, or the alburnum (sap-wood); it then passes along the upper layer of vessels and woody fibre composing the petiole, or leaf stalk; then through the corresponding ramifications of the petiole, forming the superficial layer of the network of the leaf, to return by the under surface, where it is exposed to the influence of the atmosphere, and where it parts with a considerable quantity of moisture; in fact, here respiration takes place, it then returns to the stem, and descends by the trunk and the cortex; during its ascent and descent the fluids are diffused laterally by means of the medullary rays, so as to form a communication between the centre and circumference of the stems. It is now readily understood how the elaboration or perfection of the sap of plants takes place, so as to place the peculiar secretions, characteristic of the species, in the bark, or sometimes through the medullary rays in the duramen or central old wood.

We have examples of both these constantly before us; the medicine commonly denominated *bark* is the cortex of a species of cinchona; the guaiacum, or lignum vitæ, used now so abundantly in the *decoction of sarsaparilla*, is an example of the elaborated juice residing in the heartwood. It has been calculated that $\frac{2}{3}$ of the moisture absorbed by the radicals is given off by evaporation before the complete perfection of the sap. After the sap has deposited various parts of composition in the tissue of the plants, a portion is returned to the radicles and rejected, similar to the excretions of animals. This fully explains why one plant will not grow where another of the same species thrived before it; it also demonstrates the necessity of changing the mould in flower-pots occasionally. This species of circulation cannot be observed by the microscope; it is principally proved by cutting the stems of trees in the spring, when the sap first begins to ascend, when it is observed exuding at the cut surface of the alburnum; also by tying ligatures firmly around stems, when the portion above the ligature becomes excessively enlarged from distension.

The first species of partial or special circulation is denominated *cyclosis*, and takes place, or rather is said to take place, in a set of vessels denominated laticiferous, from conveying the contained fluid or latex. It was first pointed out by M. Schultz, but I have myself never been able to observe it, nor to obtain its vessels. They are said to differ from the other vessels of vegetables by anastomising freely, and by their calibre remaining undiminished; it is said to be exceedingly rapid, and is to be found in those plants containing a milky or colored juice, as the euphorbias, or celandine (chelidonium). By some it is said not to take place in peculiar vessels, but in the intercellular spaces; but I have no doubt myself that it does not exist. I believe the rapid flow of the sap (as demonstrated to me once by a believer,) to take place from ruptured vessels or cells; it always takes place in one direction.

The third is the most distinct, and best observed by a microscope, it is called *rotation;* I have no doubt that this exists in nearly all vegetable cellular tissue, but it is very easily put a stop to, and therefore it is with great difficulty seen in the section of stems, &c. It is usually said to be best seen in the chara. The genus chara has been subdivided into two, one retaining the original name, and characterized by the cells being spirally covered with a layer of smaller cells, and nitella, characterized by the absence of these spiral cells. In the former it is necessary to scrape the superficial cells off before it can be seen. There are three modes of simply showing it:—first, by a *live-box*, a portion put with some fluid in this is the simplest; or second, in a small phial or tube; or third, between two pieces of glass, winding some cotton round the two ends of one piece before laying the other upon it, to prevent pressing upon the plant; when the glass tube is used, it is necessary to have a cylinder perforated at each end, or something to keep out the lateral rays of light, or to prevent aberration. An infusion of opium has a remarkable effect in stopping the circular, showing that it depends on some vital process. The simplest mode of seeing the circular (but one I have seen nowhere described, it is mentioned by Meyen,) is in the radicles of the frog-bit; the stipules are usually employed, but they require a very high power.

Now in the radicles a half-inch focal lens will be sufficient, and it is the most satisfactory of all, for the rootlets are perfectly transparent, and it is beautifully distinct; also, it appears as if there were an oblique septum dividing the cells into two; from the peculiar arrangement of the currents, they sometimes appear to cross one another; the cells here are sometimes jointed, but mostly single. There are two motions described in the rotation, one of the fluid within the cells, and another of the floating particle, or their axes; I think there is no doubt that the latter is purely accidental, resulting from the collision of the particles against each other. The circulation can also be observed in many hairs of plants; in the senecios, &c. I may perhaps just mention that abundance of chara (the true chara*,) can be obtained in some slow streams, at the foot of the field beyond the church at Northfleet, near Gravesend; I have obtained it there myself, and have it growing beautifully along with nitella from Whetstone, near the turnpike.

J. W. G.

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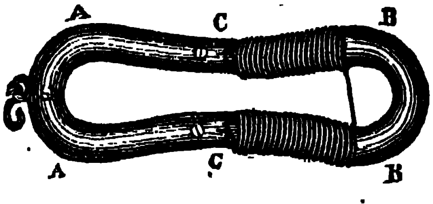
* Our Correspondent speaks of the *true* chara, he means that species which is best adapted to show vegetable circulation. There are eight or nine species of this plant, of British growth. All of them are submersed water plants, with a thread-like stem, and thread-like branches, growing from the stem in a whirl, that is, similar to the ribs of an umbrella. There are no leaves, nor flowers, most of the species are covered with a thick crust of lime, but there are four perfectly transparent and smooth; chara translucens, flexilis, nidifica, and gracilis. The first is the most common, and is that above alluded to. Besides the above given stations, it is abundant in ponds near Totteridge.—Ed.

TO EXHIBIT THE MAGNETIC SPARK IN AN EASY AND SIMPLE MANNER.

(To the Editor.)

Sir,—I would most cheerfully contribute to the pleasure and instruction of others whenever it lays in my power; if, therefore, the following experiment should be deemed worthy of insertion in your valuable pages, it is much at your service.

Possessing a steel magnet, say of two or three steel plates, of a horse-shoe shape: prepare a similarly shaped horse-shoe of good, soft iron rod, of about $\frac{1}{2}$ inch or $\frac{5}{8}$ in diameter. Round the ends or poles of the said iron horse-shoe, wind some thirty or forty feet of copper wire, covered with cotton, (*the wire may be of the size of bell wire,*) in the shape of two stout coils, letting the ends of the said coils project $\frac{1}{4}$ inch beyond the ends of the said iron poles. Now let the steel magnet be joined to the iron one, attraction of course ensues; then suddenly detaching the two, carefully letting the clean bright ends of the coils glide off the steel magnet, and a bright magnetic spark immediately ensues; perhaps an illustration would convey a better idea.



A A, steel horse-shoe magnet; B B, iron keeper to ditto; C C, the bright clean ends of copper coils, resting carefully on the ends of magnet.

Permit me to say, that I have with a similar apparatus elicited the magnetic spark from a small magnet of one bar only, whose lifting power was scarcely one pound; the above is as far as I know, my own invention, having never seen it exhibited in so simple a manner before.

W. W.

PHOTOGRAPHY.

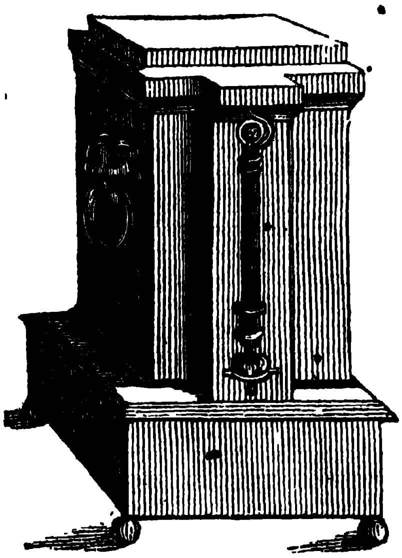
(To the Editor.)

Sir,—Permit me to inform the readers of your excellent work, of the following method of preparing a photographic paper, that gives the shades in their proper places. Make a solution of nitrate of silver in water, (1 drachm to an ounce of water,) wash one side of a sheet of paper with this solution, and let it dry *in the sun;* when perfectly black, dip it into a solution of iodide of potassium; (4 drachms to half a pint of water), let this remain for half a minute, they dry it lightly with blotting paper; Lastly, wash with a solution of the yellow prussiate of potass, the side of the paper that was before washed with the nitrate solution; dry lightly with blotting paper, and then while moist, take the impression. The parts exposed to the light will turn pale yellow, while the other parts will continue dark brown.

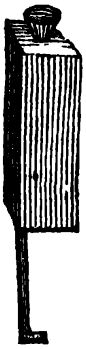
These pictures may be fixed, by dipping them into a solution of bromide of potassium; (1 drachm to 4 ounces of water), let them remain a short time, then dip them into water, and lastly dry them by the fire.

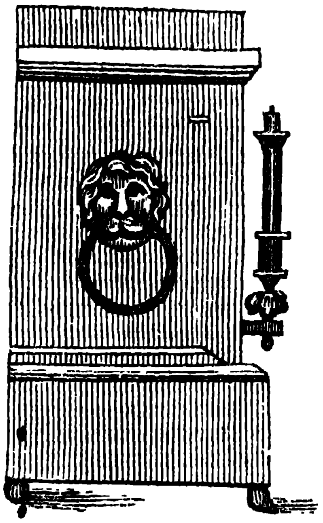
J. SAVAGE.

Fig. 1.

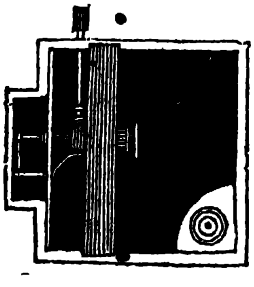


5.

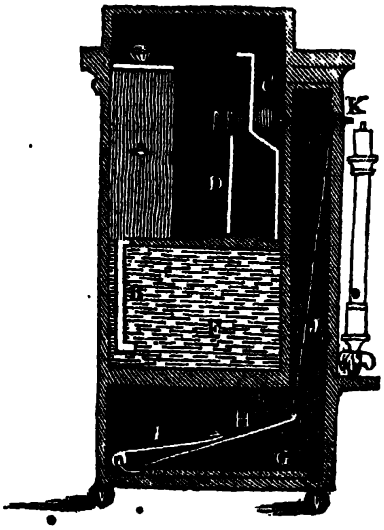


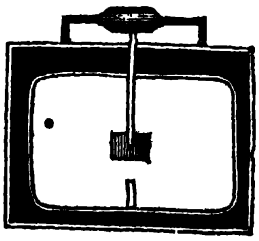


VOLTA'S AIR LAMP.



3.





VOLTA'S AIR LAMP.

We have been repeatedly requested to give a description of Volta's air lamp, or, as it may be otherwise called, electrical instantaneous light machine; we take the present opportunity of doing so, the more readily as it is an instrument but little known, and one which long after the time of its invention maintained a considerable share of public notice and favor, although now superseded by the hydrogen light bottle, and it may be truly said by the common lucifer matches; the certain and rapid method of obtaining a light now, rendering practically useless complicated philosophical light machines, however ingenious and elegant. Fig. 1 shows a perspective view of the instrument, particularly alluded to. Its case is made of mahogany, and it has a socket in front near the bottom to hold a candlestick. A candle placed in this exactly reaches to a hole made through an ornamental brass scutcheon, higher up the case. The section and position is better seen in Fig. 2, which is the side view of the instrument. The other figures show the internal structure and mode of action of the machine. Fig. 3 is a longitudinal section. Fig. 4 a transverse section of the upper part; at A is a quadrant-shaped bottle of lead, which fits into a corner of the case, seen in position at Fig. 4. This has a pipe below it, marked B; it is seen better at Fig. 5. The pipe extends also nearly all the way up the bottle. The longitudinal section shows that the case is divided into three parts—two of which are represented much darker than the rest; the third or middle portion is filled with water. The pipes C and D are both connected with this middle division; the one pipe, that at C, extends from near the bottom of E into the open space above. The pipe D is connected with the horizontal tube that leads to the jet K. A cock extends sideways as seen in Fig. 4, having a projecting handle outside the instrument. The lower part of the case contains an electrophorus; that is, two plates—the lower one G of a resinous substance, the upper one H of brass or tin. To this last a spring I is attached, though this is not necessary. A bird's-eye view of the electrophorus plate is seen at Fig. 6. From the front edge of H proceeds a wire, connected with, or rather resting upon a small projecting arm of the cock. Between the cock and wire is a small glass tube, and the wire is so bent as to rest upon the point of the jet, so that the wire from the electrophorus touches the jet, except when the handle of the cock is turned, in which case a small interval between them is made; and when the wire of the electrophorus is pulled, supposing it to be charged, a small spark will pass from one to the other. If now hydrogen gas is made to pass out at the jet, it would be inflamed by that spark, and consequently the candle would be lighted, which is the object desired. To furnish the hydrogen is the object of the upper part of the instrument. Into A are placed some pieces of zinc, sulphuric acid, and water; this of course generates hydrogen. The gas when formed flows down the pipe B, through the water, and occupies the pipe D, and the upper part of the water vessel E, driving the water out through the pipe C. When the cock is turned, the gas flows out. This instrument, as was before observed, is now laid aside, being found inconvenient on account of its size, the expense of the hydrogen, and the rapid corrosion and accidental injury occasioned to the instrument itself by the sulphuric acid used in making the hydrogen.

THE CALCULATING MACHINE.

There are few efforts of the mind more fatiguing, irksome, dry, and monotonous, than the drudgery of making long calculations. The fixed and unceasing attention to a subject in itself devoid of interest, when the slightest intrusion of thought or fancy destroys the work already done, and compels us to return our weary way, is enough to addle and stupify the brain. No wonder, then, that, from times immemorial, the ingenuity of man should have been directed to the discovery of some contrivance, whereby this wearisome labor might be lightened or abridged. Hence the invention of calculating instruments and mechanical aids of various kinds. This long-sought desideratum appears at length to have been obtained; but before we present to our readers some account of the latest attempts of this kind, we will take a rapid glance at the various endeavours previously made to accomplish the end in view, and which will place in a more conspicuous light the merits of this new invention.

The instruments hitherto contrived for assisting or abbreviating calculations may be classified as follow:—

1. Such as supersede the mere setting down of figures, but requires as close an application of the mind as common arithmetic. To this class belong the calculating boxes of the Russians and Chinese, where the figures are represented by balls moved by wires. Even the Romans possessed an instrument of this kind, called Abacus, in which the figures were indicated by buttons running in grooves.

2. To another class belong such instruments as are constructed on the following principle, viz.:—Two long slender rules are divided into 100 equal parts, those parts being numbered from 0 to 100, and are thus used: If, for instance, it be desired to add 17 to 23, the rules must be so placed that the 0 of one shall be exactly opposite to 17 in the other, then by finding 23 on the first, you will have below it on the second the number of 40 as the result. If, on the contrary, you wish to substract one number from another, as 13 from 30, the number 13 on one rule must be brought opposite to 30 on the other, and under the 0 of the former you will find 17, the remainder. Such contrivances, being of very limited utility, and partaking more of the character of toys than of practical inventions, have long since sunk into oblivion. Instruments on this principle, some square, and others of a circular form, have been produced by Perrault, in 1720; Poetins, in 1728; Peregre, in 1750; Prahl, in 1789; Gruson, in 1790; Guble, in 1799, &c.

3. A third class of instruments for assisting calculators comprises the "Virgulæ Neperianæ," as likewise the other two works of this celebrated Scotchman—namely, his "Multiplicationis Promptuarium," and his "Abacus Arealis," in 1617. In his footsteps followed Caspar Scott, 1620; Demeam, 1731; Lordan, in 1798; Leopold, Pelit, and others.

4. Equally well known with the foregoing is the calculating scale, so much used by the English in mechanics, which was invented by Michael Scheffelt, of Ulm, in 1699, called the slide rule.

All the contrivances above enumerated, and others which we pass over in this brief sketch, do certainly diminish the labor of arithmetical calculations, more or less, but they all require the attention to be fixed, and do not completely attain the object sought. Hence the aim of scientific men has been to invent an automaton, or self-acting instrument for calculation, which alone can deserve the name of a calculating machine. The first attempt of this kind was made by Blaise Pascal, in 1640. His machine performed addition and substraction mechanically; but it was so difficult to work, and the mechanism so imperfect, that it was soon discarded and forgotten. A similar destiny attended a machine for adding and subtracting, invented in England by Samuel Moreland, in 1673. His other mathematical instrument is nothing more than an adaptation of Napier's scale to circles for multiplication and division. The defects and insufficiency of these two inventions of Pascal and Moreland gave rise to subsequent endeavours to improve them. Lepine in 1725, and Hillorin de Boistissandean in 1730, were not more successful than their predecessors; nor did Gersten's invention, submitted to the Royal Society of London in 1735, afford any greater satisfaction.

In Italy, in 1709, Polenius tried his skill on a machine of this kind, but produced only a coarse unsightly abortion, incumbered with weights, that was far inferior to those which had preceded it. In all these cases the aim of the inventors was only to work addition and subtraction. Leibnitz sought to extend the operations of an arithmetical calculator to multiplication and division. The plan of his machine was submitted to the Royal Society of London in 1673, and met the approbation of the society. A similar honor attended it a short time afterwards from the Academy of Sciences at Paris. But, despite the approbation of those celebrated learned bodies, the plan which looked so promising on paper proved impracticable in execution. Leibnitz labored hard during his whole life to bring his scheme to perfection, expended vast sums upon it, and yet effected nothing. Death carried him off, and his work remained unfinished and forgotten. In 1727 Leupold promised to publish to the world the plan of a machine that should perform addition, subtraction, and multiplication; he died, leaving behind him only a few fragments of his plan. After this it seems that no further attempts were made for a long period, until, in the year 1799, a minister of Wirtemberg, named Hahn, came forward with a new machine, which, however, attracted no attention, as it was found to commit serious errors in arithmetic: its internal structure remains unknown, as does also that of a faulty instrument presented to the Academy of Sciences in Göttingen, by Muller, in 1786.

The machine constructed by Mr. Thomas Colmer in 1820, was a retrograde step in this branch of science.

In the year 1821 Mr. Babbage, of London, undertook to construct a machine for Government, which should, by mechanical means, form tables of progression for the use of surveyers. A portion of this machine, forming a progression up to five figures, was complete—17,000*l.* had been expended on it already, and to perfect the entire work would have required twice as much more; consequently, in 1833, the project was abandoned, and it is not probable that the costly machine will be brought to a perfect state.

The fragment or member alluded to may be seen at the inventor's. Mr. Babbage is at present occupied with the plan of a machine which is to perform mechanically all the operations of algebra. Already he has 30 plans extant; every friend of science must heartily wish that the inventor may be more successful with his new project than he was with the previous one. We come now to speak of the recent successful attempt before alluded to. For the last two years Dr. Roth, of Paris, has been engaged in the construction of arithmetical machines, and the success that has attended his efforts hitherto proves he has accomplished his scheme for performing automatically all the operations of arithmetic, from simple addition, subtraction, multiplication, and division, to vulgar and decimal fractions, involution and evolution, arithmetical and geometrical progression, and the construction of logarithms, with ten places of decimals. The machine in its present state works addition, subtraction, multiplication, and both kinds of progression, quite mechanically. In division alone the attention is required to avoid passing over the cipher. The arithmetical progression is of vast importance, as it operates from one farthing to millions of pounds sterling; and when we consider the variety and utility of the functions performed by a small instrument, not more than a foot wide, and its comparatively insignificant price, we cannot but congratulate the inventor on his decided success in the results hitherto obtained, and express our cordial wishes that he may meet with every encouragement to persevere in his highly interesting and important labors.

Mr. Wertheïmber, the proprietor and patentee of this invention, has two descriptions of these machines—a larger one which performs sums in addition, subtraction, multiplication, and division;—and a smaller, which performs addition and subtraction only. These machines have been submitted to the inspection of several gentlemen eminent for their scientific attainments, all of whom, particularly Mr. Babbage, have expressed the most unqualified admiration at their unparaleled ingenuity of construction.—*Times.*

THE PANARY FERMENTATION.

The theory of the fermentation of dough and the making of bread is involved in considerable obscurity. The following comprises almost the whole of what is known of it.

The fermentation which takes place in dough was once considered peculiar to bread, and hence was named the *panary* fermentation. The chief ground of this opinion was, that if dough in this state be distilled, it does not afford alcohol; although it might have been expected to do so, if the fermentation which it had undergone were the vinous. But this view of the subject was found to be incorrect, by its being ascertained that infusion of malt, mixed with yeast, although it certainly undergoes the vinous fermentation, gives no evidence of its having done so by the test of distillation; for if it be distilled during the beginning of the process, it will not afford alcohol any more than the dough. Beside this negative proof, we have one of a positive nature. It has been found by experiment that dough, when sufficiently fermented, actually does afford alcohol. It is, therefore, manifest that there is no specific difference between the two exhibitions of fermentation; one is the beginning, the other the sequel: in the one carbonic acid only is produced; in the other alcohol also is generated.

According to the analysis of wheaten flour by Vogel, one hundred parts contain five of a peculiar sugar. We may therefore suppose that the action of the yeast, made use of in the process of fermenting the dough, is exerted on this sugar; that it is decomposed; that carbonic acid is formed, and at length alcohol. The small quantity of sugar present in the flour accounts for the small quantity of carbonic acid evolved in the dough. But there is unquestionably some other chemical change produced; for the bread when finished contains neither of its two chief constituents, the gluten and starch. These two principles are known to exert a chemical action on each other, and to produce saccharine matter. But during the fermentation and baking of dough we do not find that sugar is formed: we must therefore suppose that both the gluten and starch, by their mutual action, are converted into some intermediate state of existence. When sugar is formed by the action of these two principles on each other, it is the starch that suffers the conversion; the gluten is but little affected. But during the change which takes place in the fermentation of dough, the gluten is as much acted on as the starch, and hence its change is as complete. Perhaps the difference in the nature of the change is attributable to the very elevated temperature at which the chemical action takes place in the oven.

Concerning these changes, the opinion of M. Duportal is, that the yeast, after having converted the sugar of the flour into carbonic acid and alcohol, changes the latter into acetic acid; that, at the same time, the gluten and the albumen are in part decomposed, acetic acid is again produced, some ammonia, and more carbonic acid; and that, the starch *uniting* with the undecomposed gluten, there results a compound, the further alteration of which is prevented by the action of fire, which combines these principles still more intimately. This theory M. Duportal conceives to be supported by the following facts:—

"1st, Those farinæ which are deprived of the fermenting principle, or those which scarcely contain any of it, always afford heavy bread, although the saccharine principle forms a part of them; for this substance not being a fermentable principle, it cannot ferment of itself, although it does so by means of a ferment. Thus it is customary to add to the dough a leaven, taken from bread already fermented, or the yeast of beer.

"2d, Dough is always acid, notwithstanding that the volatile alkali formed in the operation neutralises one part of the acetic acid, as is proved by the ammoniacal odour of dough treated by potash. Bread itself always contains a little of this acid, which heightens the flavor of it.

"3d, The starch, the undecomposed gluten, and the other materials of the dough, are so intimately united by the baking, that it is no longer possible to separate them. We can discover, by the distillation of bread, an animal matter, for it forms acetate of ammonia; but a less quantity of this is obtained from it than from farina, according to the observations of M. Vauquelin.

"4th, The formation of carbonic acid is rendered evident by the volume which the dough acquires, and by the numerous cavities which are to be seen in it. This gas escaping while the bread is baking, dilates the mass still more, which causes the air to lodge in these cavities—an important circumstance; whence results the remarkable whiteness of bread full of little holes, so light, delicate, and sapid, in comparison with the bread destitute of them, which is heavy, compact, and of a disagreeable taste.

"It is, therefore, more particularly the ferment which has the most active share in producing panification. Added to dough in small qua[illegible] the operation is slow and incomplete; in too large proportion, the fermentation goes on so rapidly that it becomes necessary to check it. In this last case, M. Chaptal proposes to knead some carbonate of potash with the dough, which will neutralise the excess of acetic acid. Our good housewives content themselves with uncovering the dough, dividing it, and exposing it to the air, in order to diminish the temperature of the fermenting mass; and this management sometimes succeeds."

The coarser kinds of sugar, along with the pure saccharine principle, contain a ferment proper to themselves. The sugar produced by the action of sulphuric acid on starch is also associated with its proper ferment. There can be little doubt that the saccharine substance obtained by the mutual action of gluten and starch contains a peculiar ferment. Hence, all these kinds of sugar would spontaneously enter into the vinous fermentation. Accordingly we find that wheaten dough spontaneously ferments; and we must attribute the change to the presence of a natural yeast belonging to the peculiar sugar which wheaten flour has been proved to contain. The vinous fermentation, when once it has commenced in dough, will proceed into the acetous stage, and from that it will go on to the putrefactive. We can, therefore, be at no loss to understand the nature of leaven. We comprehend why a mixture of flour and water, after some time becomes inflated in all parts with air bubbles; why it turns sour, and finally fetid. And we can perceive why a piece of this leaven, in a state of active decomposition such as has been described, will induce the same sort of change, almost immediately, in a quantity of dough, which, without such mediation, would also have undergone the same subversion of its affinities, but after a greater lapse of time.

Although the sugar contained in corn is associated with a natural ferment, and although this ferment is found capable of exciting the vinous fermentation in dough, it is not adequate to produce a proper vinous fermentation in watery infusions of the grain. On the contrary, such infusions pass rapidly into the acetous stage. There is evidence, however, of the previous existence of a vinous fermentation, transitory, it is true, but still sufficient to generate alcohol in a quantity that may be appreciated by distillation: but in the case of dough the results are a little different; the small quantity of water present, the obstruction to chemical action occasioned by the stiffness of the paste, and, perhaps, other causes, operate in such a way as to protect the fermentation from the approaches of acetification, and to continue the vinous stage until the operation of the oven puts an end to it.

MANAGEMENT OF GREEN-HOUSE PLANTS.

THE cultivation of exotic plants, whether pursued with the view of producing fruits or flowers, must be admitted to hold a conspicuous rank in horticultural science. A taste for the enjoyments of this pursuit existed at a very early period, and it has kept pace with the more refined and peaceful arts wherever these have flourished. The writings of the ancients sufficiently prove, that, among the nations of antiquity, a very strong attachment existed for the cultivation of exotic flowers, and this has continued progressively to increase up to the present time. Green-houses and stoves were first erec[illegible] this country during the seventeenth century; and during the early part of the eighteeenth century, the cultivation of exotic plants was carried on with great spirit, upwards of five thousand being introduced from foreign countries, besides the recovery of many neglected species. The latter part of the eighteenth, and the beginning of the nineteenth century, however, has been the great botanical era for which this country will ever be conspicuous. The discovery of Australia, the extension of the British power in India and both the Americas, aided by the patronage of the most wealthy aristocracy in the world, have brought a combination of power to bear on botanical discovery, which has been attended with the most happy result. Not only have botanical and horticultural gardens been established in all our principal cities, but private ones are maintained with princely liberality by many of our nobility and gentry. Indeed the taste for exotic botany and floriculture seems to prevail among all classes; and the number of collectors employed in different parts of the world is a proof that the taste is rapidly increasing.

We will now speak of the green-house itself, for a great deal depends upon adapting the structure as well as the temperature of it to the plants to be cultivated in it. The house sufficient for small plants of course will not accommodate those of larger growth; and it is equally true, that a house capable of accommodating the latter is unfavorable to the smaller plants, which uniformly require being placed as close to the light as circumstances will permit. Again, the situation which is best calculated for an orangery, or a camellia-house, which require but a very moderate supply of air and light, would by no means do for a heathery or geranium-house, to which air and light cannot be supplied too abundantly. Indeed, so various are the *desiderata* for plants requiring artificial cultivation, that we earnestly advise every amateur, unless his means are as ample as those of the proprietors of Sion House or Alton Towers, to confine his attention to a few families most nearly alike in their habits, instead of congregating a confusion of plants of dissimilar habits, and requiring different temperatures, into one building. Their object should be to form judicious selections, instead of a numerous collection; and not to sacrifice real excellence to an idle passion for variety. Indeed, no one should attempt the artificial cultivation of plants as a general collector, unless he has means and space to afford separate buildings for those families which demand somewhat singular degrees of light, temperature, and air; for otherwise, by continually varying the supply in these particulars, to force this plant or check the other, he will injure, if he does not destroy, the whole. Our continental neighbours exhibit much more prudence in this respect than we have hitherto done; and even our garden florist sets us a good example by confining himself to a few families—to his tulip bed, his auricula stage, or his carnation stand, for instance, preferring excellence in one department to mediocrity in all. Subjoined are a few operations demanding the notice of the amateur.

WOODY GREEN-HOUSE PLANTS.

The means of propagating these plants is by cuttings, but a few sorts are sometimes layered, grafted, or inarched, and a number are raised from seeds. Propagation from cuttings should be commenced about the end of January; cut and dress them neatly with a sharp penknife, taking off all the leaves as close to the shoot as possible, except a few at the top, to be left for the free respiration of the cutting. This should be particularly attended to in making cuttings for evergreens, whether tender or hardy. Let them be cut off at the bottom, with a clean, horizontal cut at a joint or bud, and placed immediately in their proper pots, which it is very necessary to have properly prepared, half filled with mould or compost, and afterwards filled with good loam or sand, and well drained. Cover them with proper glasses, so as to exclude the air; then plunge them in a back-pit or in a hot-bed frame, made for the purpose, shading them from the powerful rays of the sun, until they are sufficiently strong. May and June is the most proper time to propagate such as myrtles, oranges, metrosideros, banksias, &c. If begun in June, which is early enough, they must be placed in a cool, shady situation; an exhausted hot-bed, with a frame and good lights on it, will answer very well; in July and August there will be many of the earlier cuttings growing; they should have their glasses taken off, as before directed, and be set for a few days in a more exposed situation, to harden them by degrees, in which they must be shaded from the mid-day sun, but freely exposed to the air at night. Water should be freely administered, except in foggy damp weather, and then sparingly.

GERANIUMS.

The ordinary mode of propagating each species and variety of the geranium is by cuttings; but almost all the sorts produce ripe seeds in this country, by which they may be multiplied, and new varieties produced. The seed, if ripe before Midsummer, may be sown as soon as gathered, in pots of light rich earth, and placed in a gentle hot-bed, and shaded. The plants will soon come up, and when they show two proper leaves may be transplanted singly into pots, kept under a cold frame. Several of them will flower in the following spring and summer. The shrubby or suffruticose species of this family grow more readily by cuttings, which may be taken off at a joint where the wood is beginning to ripen, and laid in the shade for an hour or two till the wound heals, and then planted in sandy loam, and placed in a gentle heat. The hardier sorts may be planted in the open air, or in any shaded situation, without being covered with a glass. From the latter end of March to the end of July, cuttings of all the common kinds may be put in with success. Make a moderate hot-bed, surfaced with some old tan, and when of a proper temperature, let the cuttings be made and put in some rich loam; plunge the pots to the rim in the beds, and shade them for a day or two, but no longer; water them occasionally, and pot them off in due time; by which means they will be stout plants by the end of the autumn. Geraniums require a rich light soil; they grow well in equal parts of sandy loam and well-rotted dung; or they will grow in leaf-mould and a little sand, without any thing else. As most species are rapid growers, the pots require examining in spring and autumn, and the roots and top reduced, or the plant shifted into a larger pot. The shrubby sorts should be kept low and bushy by pruning: for when allowed to grow tall and straggling, they are very unsightly, and do not flower well. The hardier sorts may be placed in the open air from May to September, and in warm situations they may be planted in the borders of the flower garden or shrubbery; these have a good effect till attacked by frost, when they may be protected by abundance of litter and mats, or they may be removed in single pots, and placed in a dry part of the greenhouse till the following spring.

MISCELLANEOUS CHOICE FLOWERS.

The Fuchsia.—This elegant and ornamental shrub, though requiring the green-house in the winter, will grow vigorously, and flower freely in the open air, during summer. The most beautiful are coccinea, gracilis, virgata, conica, microphylla, and some hybrids lately raised, such as globosa, Thompsonii and Robertsii. All are propagated with the greatest ease by cuttings; and they may either be planted out of a small size, in spring, or trained in pots, for two or three years, till they form the tree-like shrubs, of five or six feet in height, when they may be turned out at the beginning of every summer and taken up every winter. Some of the more hardy will stand over the winter, dying down to the ground, and shooting up vigorously the following spring.

The Camellina celestis is a perennial, which will flower the first year, if treated like a tender annual; while if its fleshy roots are preserved through the winter in dry sand, excluded from the frost, they may be planted out in the following spring, after being brought forward a short time in a hot-bed. Sow the seeds early in spring, on a moderate hot-bed, and bring the plants forward in separate pots, turning them out in the open garden in the beginning of May, or sow in the open ground in the beginning of March. Light rich soil is preferable.

The Verbenas are beautiful half hardy perennials, which form brilliant ornaments to the flower-garden during summer. They are propagated by cuttings kept through the winter, in small pots, and turned out when all danger from frost is over. Light rich soil suits them best.

Balsams.—The varieties of these tender annuals are infinite; the seeds from one plant will hardly produce two alike. They are raised almost always from seeds, but they may be propagated by cuttings. The seed should not be less than three or four, or even nine years old, gardeners having experienced that new seed seldom produces double flowers. The best soil is a rich loam, rather lighter than that used for melons. Sow between the 1st of March and the 1st of May, in pots, very thin; place them in a hot bed and as near the glass as possible. When the plants are five inches high, transplant them into No. 48 pots, one plant in the centre of each pot. As the roots fill the pots, move them into larger ones, and repeat this three or four times, keeping the plants all the time in a hot-bed and near the glass, or in a pit. Balsams, so treated, will rise four feet high and fifteen feet in circumference, with strong thick stems, richly covered with large double flowers.

The Amaranthus Tricolor, Celosia cristata or Coxcomb, Gomphrena globosa or Globe amaranth, Mesembryanthemum crystallinum or ice plant, Solanum melongena or egg plant, and most other tender annuals will attain to corresponding luxuriance if similarly treated.

The Hydrangea.—A succession of young plants may be raised each year by taking, in the early part of July, young shoots with three or four joints, cutting them off close to the bottom joint. These are planted in rich earth, in a warm border, and covered with a hand-glass. Shade them during the middle of the day, and water them gently every other evening, keeping the glass close over them. The cuttings will be well watered in August, and may be potted in September, and placed under a frame, keeping them shaded and watered as before. By [illegible]d of October take them into the green-house for the winter, and water them once a week or a fortnight, as they may require. By the end of May they may be turned out in the open borders, into a rich bed of earth, and there remain till September, when they must be taken up and potted, and placed in the green-house, as in the preceding winter.

Chrysanthemums.—No plant is more easily cultivated than this. The root may be divided, and suckers taken off, or cuttings taken in, the beginning of April, from the top shoots of last year's plants. They are planted in pots, called sixties, in mould made up of equal parts—loam-sand and bog-mould. Take the cuttings three inches long, and cut them smoothly across at a joint; one is put in each pot, and the pots set in a frame, on a gentle bottom heat; in three weeks or a month they are well rooted, and then hardened in a cold frame till the beginning of June, when they are shifted into 48 sized pots, and placed in an open airy situation. Here they are watered with liquid manure, in which soap-suds have been mixed. About this time the tops of the plants are nipped off, to make them bushy. In August shift into 32 size pots, using strong loam with about one-third of rotten dung, and tie the plants to sticks. The old plants, if shaken out of the old mould, and repotted in 48 size pots, afterwards 32's, and in August 16's, will form large showy plants.

Heart's-ease.—Nothing can be more easy than the propagation of these plants, either by seeds or cuttings, but by the latter mode with the greatest ease in common garden soil. Seeds may be sown early in spring, under hand-glasses or in a cold frame, and the plants may be first pricked out under a glass, and afterwards transplanted into beds in the open garden, or put into pots. The situation best adapted for *pansies* should be open to the east or west. The surface should be low, so as to retain moisture, and be cool. The soil a sandy loam highly manured.

THE ORGAN OF TASTE.

BY M. DONOVAN, ESQ.

THE subject of this article, curious and interesting as it would become if industriously pursued, has scarcely occupied the attention of those who have inquired into the mysteries of the external senses. The investigation of the properties of the organ of taste is attended with peculiar difficulty, because this sense is more variable than any other amongst mankind, and is not permanent in the same person.

The nature of taste has never been explained beyond the simple statement of the fact, that it is an impression made chiefly on the nerves of the tongue and the mucous membrane of the palate.

This impression may be made by the contact of certain solids, liquids, and elastic fluids. Nitrous oxide gas received into the mouth tastes sweet; carbonic acid is acerb; hydrogen has a taste that cannot be expressed: it is perceived on acid fruits which have been that instant cut with an iron knife; ammoniacal gas has an insupportably pungent taste; and chlorine is astringent. The taste of solids and liquids need scarcely be alluded to.

Some solids that have no taste in their ordinary state acquire it in a singular way; thus certain metals have no taste unless they have been recently rubbed: others, that are perfectly tasteless when separa[illegible] acquire one when they are brought in contact with each other.

Taste is not an attribute of ponderable matter exclusively; if a stream of electricity be directed on the tongue from a pointed wire attached to the conductor of an electric machine, a distinct flavor is observable. Sometimes tastes are perceived without the application of any external exciting cause to the organ; thus impressions of sourness, bitterness, and saltness, are common results of disease.

Substances used as food have always a certain degree of taste, and, within limits, the more decided the taste the more agreeable the aliment; this quality is called *sapidity*. The absence of it, or *insipidity*, is so great a defect that it renders a substance unfit for food: the presence of such in the mouth is capable of exciting nausea, and even the evacuation of the stomach. To some persons, chewing a soft cork or a bit of white paper is a sufficient emetic. Water, of the same temperature as the mouth, acts in a similar way; but cold water acquires taste from the air contained in it, and its coldness.

Tastes are scarcely ever simple impressions, but are the result of two or more acting at the same time. The resulting effect is often very different from the elementary tastes, and not a mixture of them; and this happens even when chemical combination has not taken place. If wild carrot-seed be fermented on ale, the latter acquires the taste of lemon-peel, although neither the ale nor the seed had the least flavor of the kind: and the common carrot acts in soups precisely as if salt had been added.

It is a curious fact that the elementary impressions which produce a compound taste, need not always be applied to the mouth at the same time, but may be applied as well in succession. The fruit of the shrub called *assabah*, which is common in Dahomy, is nearly destitute of all flavor; if chewed, it nevertheless so affects the nerves serving to the organ of taste, that all acids taken afterwards into the mouth appear sweet: vinegar will be mistaken for sweet wine, and a lime for a sweet orange.

This effect is, no doubt, produced by a certain impression left on the nerves of taste, after the cause is withdrawn, and of which the person who makes the trial is not conscious. It would appear that the nerves affected become torpid to that impression, and remain so until they are excited to action by the application of some other; and then the original one revives. A person who eats a raw onion will, after a while, cease to perceive its flavor in his mouth; but in an hour or two he may renew it by swallowing a cup of tea; or, if the atmosphere be warm, by a draught of very cold water. The taste of a boiled onion is best renewed by a small quantity of brandy, diluted with much water. If the aroma of pepper be diffused over the mouth, the painful heat of it will at length subside; but let the experimenter take into his mouth a little brandy, much diluted, and he will perceive the heat of the pepper to return, and the brandy will appear to him much stronger than it really is. Those who practise frauds on ardent spirits are quite aware of this property of aromatic substances: they first let down the strength of the spirit with a little water, and then bring it up again by infusing Cayenne pepper or cardamom seeds; the stimulus of the pepper on the palate disposes it to perceive the pungency of the spirit, even in a higher degree than it would otherwise have done: and that this is a mere deception of the nerves of the organ is plain, from the fact that the taste of the pepper is not perceived, while that of the spirit is; the latter being so much greater in quantity. The taste of even the strongest brandy will be enhanced if a single cardamon seed had been previously chewed. The contrary practise has been sometimes resorted to; although I believe it is almost universally discontinued. When wine is new, the fiery taste of its brandy predominates on the palate: to disguise this it was not unusual to add to the wine a small portion of sugar of lead (a poison,) which, by its sedative effect on the organ of taste, caused the pungency of the brandy to be less perceptible. This was not the only case in which sugar of lead was used.

To predispose the organ of taste to certain impressions is a device which has been long practised, —perhaps always. It is an old method of creating a relish for wine to preface the exploits of the evening by eating a few morsels of meat, broiled with a large proportion of pepper and mustard: the stimulus on the palate not only continued for some time, but was perhaps reproduced after it would naturally have subsided; and the organ of taste, thus prepared, perceived a more exalted flavor in the wine than would otherwise have belonged to it, the effect being quite in dependent of thirst.

The burning sensation produced on the mouth by aromatic substances may be reproduced by liquids having a much higher or a much lower temperature than the mouth itself. Thus when the heat of pepper has subsided on the palate, it may be renewed, in a slight degree, by a draught of very cold water; and when the peculiar burning occasioned by chewing peppermint leaves has disappeared, a quantity of hot water taken into the mouth will restore it.

The substances which produce and reproduce a stimulus on the organ of taste need not always be acrid or heating: some that are remarkable for mildness of flavor are equally efficacious. Thus the root of liquorice, when long chewed, leaves an impression of feeble sweetness, which very gradually subsides: as soon as it is no longer perceptible let the person take a draught of buttermilk, and instantly the sweetness will return. The extract of liquorice, sold under the name of Spanish juice, possesses the same property with regard to porter, in a slight degree it is true, but sufficiently to modify the taste of it in a manner that is agreeable to many: I have accordingly known persons who prepared their palate for a relish of this kind by chewing some of this extract previously to taking a draught of porter. On a somewhat similar principle many people approve of ale after a fruit pie, when weak acidulous wines, as hock, would be disagreeable; for although a sweet and sour form a good combination, the latter does not bear to follow the former.

When stimuli have been applied to the organ of taste, and the perception of flavors has thus been rendered more than ordinarily acute, it will be found that weak and vapid liquors will appear to still greater disadvantage. Of this a person need have no better proof than taking a draught of weak and acescent beer after eating a highly seasoned salad, it will be rendered far more disagreeable; whereas ale, in high order from the bottle, and foaming with carbonic acid, will be rendered more pungent and penetrating than ever. It is on the same principle that coffee should never precede tea, but ought to follow it; and then both beverages will produce their proper effect: this order, however, is rarely observed, because coffee is an exciter of thirst; the nerves which supply the organ of taste are overpowered by the rough astringent bitterness of the coffee, and are then not in a condition to perceive the delicate flavor of tea—for delicacy is its chief perfection. Those physicians appear to be right who direct that delicate persons should create a a relish for a tea breakfast by the preparative of a slice of toasted bacon; few things are more successful in rendering tea enticing.

(To be continued.)

POLARIZATION THE CAUSE OF THE RAINBOW.

(To the Editor.)

SIR.—I should feel much obliged by your inserting the following in your Magazine.

When a portion of a rainbow is viewed through a tourmaline, and the tourmaline is turned round, till the direction in which it polarizes light coincides with the chord of the arc viewed, that portion entirely disappears, in consequence, (I think,) of the colored rays being composed of polarized light. No work with which I have met makes the slightest mention of this phenomenon, which I think would modify the explanation given of the formation of the rainbow, wherein polarization is not hinted at.

J. WILLSMER.

CURIOUS EXPERIMENT.

(To the Editor.)

SIR.—An old subscriber to your truly original and talented work, would feel much obliged if the editor, or any one of his numerous scientific and talented correspondents, would favor him, and a numerous circle of fri[illegible] the rational and true chemical explan[illegible] following surprising experiments, given in "Ferguson's Lectures on Select Subjects," page 178, article, Pneumatics:—"Air that will take fire at the flame of a candle may be produced thus:—Having exhausted a receiver of the air-pump, let the air run into it through the flame of the oil of turpentine; then remove the cover of the receiver, and holding a candle to that air, it will take fire and burn quicker or slower according to the density of the oleaginous vapour."

As Ferguson wrote and flourished before the new chemical nomenclature had been regularly established, it could not be expected that he would give any rationale of the phenomenon which, indeed, he no more than barely records, but which I consider of so remarkable a nature as to deserve the clearest explanation which the most improved modern science can give to it. I have, however, in vain looked through modern works on chemistry without being able to find anything to throw a light upon it, or anything analogous thereto.

INDICATOR.

[We would ask if our friend has tried and found the experiment to succeed; if not a fact, it is vain arguing upon the subject; if true, it may, perhaps, be accounted for, by the fact that bodies of a fatty nature previous to ignition give out carburetted hydrogen. If this be collected, and in contact with oxygen it will inflame. Our doubt is, firstly, whether there will be a sufficiency of hydrogen thus collected to produce the effect; and, secondly, if there be enough, whether explosion will not ensue. —ED.]

MEDICAL RECEIPTS, &c.

Spilsbury's Antiscorbutic Drops.—A nostrum composed of 2 ounces of bichloride of mercury, 1 dram each of prepared sesqui-sulphuret of antimony and red sanders-wood, rasped, 2 ounces each of orange-peel and gentian root, ½ pint each of rectified spirit and of distilled water; macerate and filter, so as to form a tincture. Dr. Hancock found no mercury in a specimen purchased of the proprietor.

Spruce Beer is made by adding 4 drams of essence of spruce to 10 gallons of water, and 4 pounds of sugar for white, and treacle for brown spruce; add also yeast in the same way as for ginger-beer, and bottle up.

Spruce Beer Powders.—Take 5 scruples of white sugar, 24 grains of sesqui-carbonate of soda, and 10 grains of essence of spruce, for the blue paper, and ½ dram of tartaric, or, what is better, citric acid, for the white paper. Dissolve in separate glasses of water; mix, and drink immediately.

Squire's Elixir.—A nostrum composed of 20 drams of opium, 1 ounce of camphor, 1 dram each of carbonate of potass and cochineal, 2 ounces of burnt sugar, 1 pint of tincture of snakeroot, 2 gallons of spirit of anise, and 8 ounces of sulphate of tin. Other formulæ are given, containing camphor, liquorice, &c., but opium is the basis.

Starkey's Soap.—A nostrum prepared by triturating for a long time, and carefully, carbonate of potass with oil of turpentine, with the addition of a small quantity of water.

Steers's Opodeldoc.—A nostrum composed of 1 ounce of Castile soap, 8 ounces of rectified spirit, 3½ drams of oil of rosemary, 1 dram of oil of origanum, and 4 drams of liquor of ammonia.

Stephens's Remedy for the Stone, was a soap made with lime procured from egg-shells, and snail-shells calcined. Along with this soap, which was given in form of pills, a diuretic and laxative decoction was given, prepared with chamomile, fennel, parsley, and burdock, with some Alicant soap. When pain was produced an opiate was given, and when the decoction purged, it was intermitted.

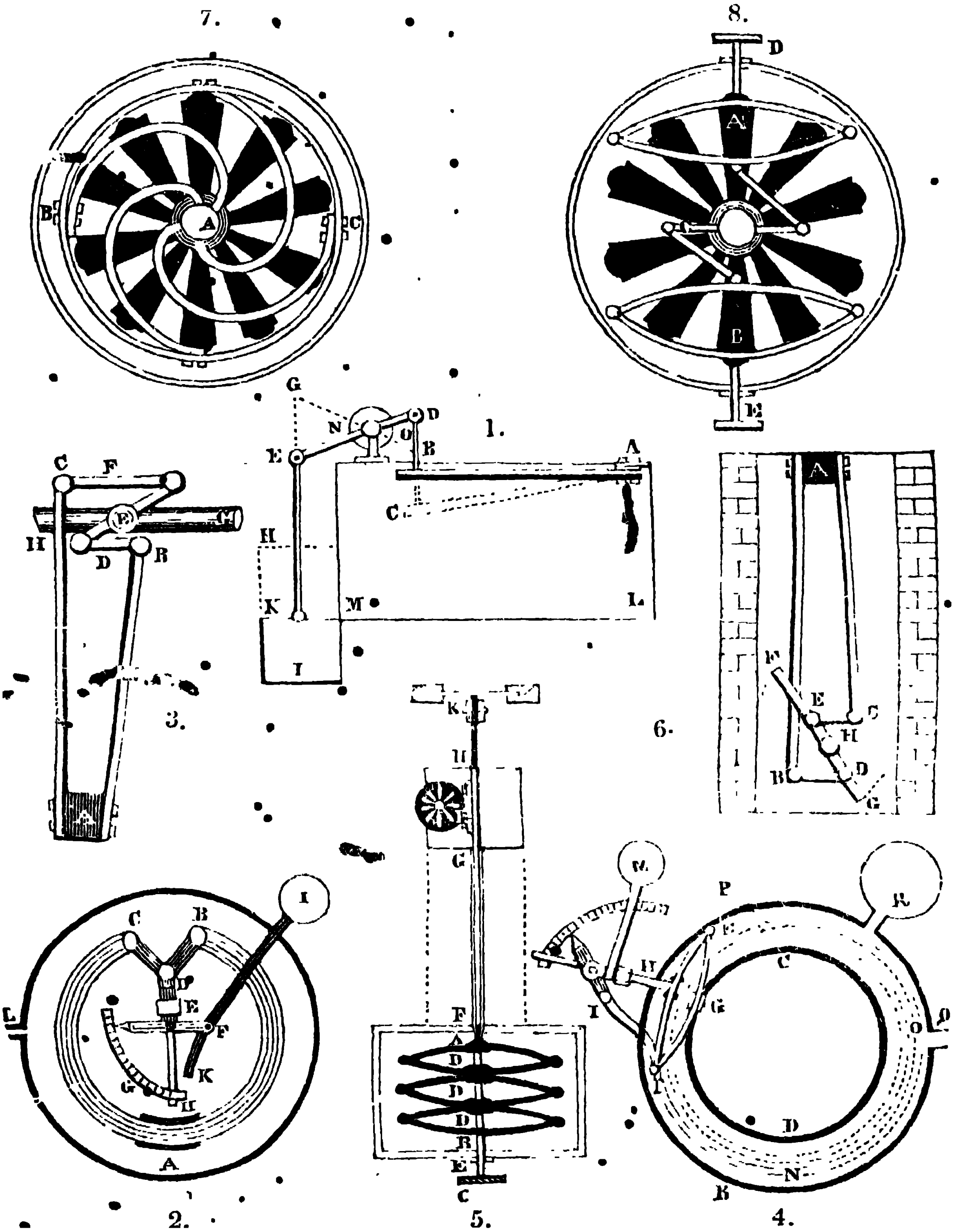
Sterry's Plaster.—A nostrum very popular in London, and composed of the common ammoniac plaster of the Pharmacopœia, or ammoniac dissolved in vinegar, and spread on brown paper.

Storey's Worm Cakes.—A nostrum composed of 1 scruple of jalap, 1 dram of ginger, 2 scruples of sugar, 1 ounce of cinnebar, and as much of syrup as is sufficient to make them into cakes.

Stoughton's Elixir.—A nostrum composed of a compound tincture of gentian made with 2¼ pounds of gentian root, 1 pound of Virginian snakeroot, 1¼ pound of dried orange-peel, 4 ounces of calamus aromaticus, and 6 gallons each of rectified spirit and water. Cardamoms are sometimes added.

Struve's Lotion for Hooping-Cough.—A nostrum composed of 1 dram of potassio-tartrate of antimony dissolved in 2 drams of distilled water, to which add 1 dram of tincture of cantharides. It is curious to see this coming again into fashion, under the auspices of the late venerable Dr. Jenner, under the form of antimonial ointment.

Tonic Wine (French).—A nostrum which originated with the editor of the "Medical Adviser," consisting chiefly of tincture of aloës and other purgative tinctures.



DR. URE'S THERMOSTAT.

DR. URE'S THERMOSTAT.

Thermostat is the name of an apparatus for regulating temperature, in vaporization, distillation, heating baths or hothouses, ventilating apartments, &c.; and for which Dr. Ure obtained a patent in the year 1831. It operates upon the physical principle, that when two thin metallic bars of different expansibilities are riveted or soldered facewise together, any change of temperature in them will cause a sensible movement of flexure in the compound bar, to one side or the other; which movement may be made to operate, by the intervention of levers, &c., in any desired degree, upon valves, stopcocks, stove-registers, air-ventilators, &c.; so as to regulate the temperature of the medium in which the said compound bars are placed. Two long rulers, one of steel, and one of hard hammered brass, riveted together, answer very well; the object being not simply to *indicate*, but to *control* or *modify* temperature. The foregoing diagrams illustrate a few out of the numerous applications of this instrument.

Fig. 1. A B is a single thermostatic bar, consisting of two or more bars or rulers of differently expansible solids (of which, in some cases, wood may be one): these bars or rulers are firmly riveted or soldered together, face to face. One end of the compound bar is fixed by bolts at A, to the interior of the containing cistern, boiler, or apartment A L M B, whereof the temperature has to be regulated, and the other end of the compound bar at B, is left free to move down towards C, by the flexure which will take place when its temperature is raised.

The end B is connected by a link B D, with a lever D E, which is moved by the flexure into the dotted position B G, causing the turning-valve, air-ventilator, or register, O N, to revolve with a corresponding angular motion, whereby the lever will raise the equipoised slide damper K I, which is suspended by a link from the end E, of the lever E D, into the position K H. Thus a hothouse or a water-bath may have its temperature regulated by the contemporaneous admission of warm, and discharge of cold air, or water.

Fig. 2. A B C is a thermostatic hoop, immersed horizontally beneath the surface of the water-bath of a still. The hoop is fixed at A, and the two ends B C are connected by two links B D, C D, with a straight sliding rod D H, to which the hoop will give an endwise motion, when its temperature is altered; E is an adjusting screw-nut on the rod D H, for setting the lever F G, which is fixed on the axis of the turning-valve or cock F, at any desired position, so that the valve may be opened or shut at any desired temperature, corresponding to the widening of the points B C, and the consentaneous retraction of the point D, towards the circumference A B C, of the hoop. G H is an arc graduated by a thermometer, after the screw-piece E has been adjusted. Through a hole at H, the guide-rod passes. I, is the cold-water cistern; I F K, the pipe to admit cold water; L, the overflow pipe, at which the excess of hot water runs off.

Fig. 3, shows a pair of thermostatic bars, bolted fast together at the ends A. The free ends B C are of unequal length, so as to act by the cross links D F on the stopcock E. The links are jointed to the handle of the turning plug of the cock, on opposite sides of its centre; whereby that plug will be turned round in proportion to the widening of the points B C. H G is the pipe communicating with the stopcock.

Suppose that for certain purposes in pharmacy, dyeing, or any other chemical art, a water-bath is required to be maintained steadily at a temperature of 150° F.: let the combined thermostatic bars, hinged together at E F, Fig. 4, be placed in the bath, between the outer and inner vessels A B C D, being bolted fast to the inner vessel at G; and have their sliding rod K connected by a link with a lever fixed upon the turning plug of the stopcock I, which introduces cold water from a cistern M, through a pipe M I N, into the bottom part of the bath. The length of the link must be so adjusted, that the flexure of the bars, when they are at a temperature of 150°, will open the said stopcock, and admit cold water to pass into the bottom of the bath through the pipe I N, whereby hot water will be displaced at the top of the bath through an open overflow-pipe at Q. An oil bath may be regulated on the same plan; the hot oil overflowing from Q, into a refrigeratory worm, from which it may be restored to the cistern M. When a water bath is heated by the distribution of a tortuous steam pipe through it, as I N O P, it will be necessary to connect the link of the thermostatic bars with the lever of the turning plug of the steam-cock, or of the throttle valve I, in order that the bars, by their flexure, may shut or open the steam passage more or less, according as the temperature of the water in the bath shall tend more or less to deviate from the pitch to which the apparatus has been adjusted. The water of the condensed steam will pass off from the sloping winding-pipe I N O P, through the sloping orifice P. A saline, acid, or alkaline bath has a boiling temperature proportional to its degree of concentration, and may therefore have its heat regulated by immersing a thermostat in it, and connecting the working part of the instrument with a stopcock I, which will admit water to dilute the bath whenever by evaporation it has become concentrated, and has acquired a higher boiling point. The space for the bath, between the outer and inner pans, should communicate by one pipe with the water cistern M, and by another pipe, with a safety cistern R, into which the bath may be allowed to overflow during any sudden excess of ebullition.

Fig. 5, is a thermostatic apparatus, composed of three pairs of bars D D D, which are represented in a state of flexure by heat; but they become nearly straight and parallel when cold. A B C is a guide rod, fixed at one end by an adjusting screw E, in the strong frame F E, having deep guide grooves at the sides. F G is the working-rod, which moves endways when the bars D D D operate by heat or cold. A square register-plate H G, may be affixed to the rod F G, so as to be moved backwards and forwards thereby, according to the variations of temperature; or the rod F G may cause the circular turning air-register I to revolve by rack and wheel-work, or by a chain and pulley. The register-plate H G, or turning register I, is situated at the ceiling or upper part of the chamber, and serves to let out hot air. K is a pulley, over which a cord runs to raise or lower a hot-air register L, which may be situated near the floor of the apartment or hothouse, to admit hot air into the room. C is a milled head, for adjusting the thermostat, by means of the screw at E, in order that it may regulate the temperature to any degree.

Fig. 6 represents a chimney, furnished with a *pyrostat* A B C, acting by the links B D E C on a damper F H G. The more expansible metal is in the present example supposed to be on the outside.

The plane of the damper-plate will, in this case, be turned more directly into the passage of the draught through the chimney by increase of temperature.

Fig. 7 represents a circular turning register, such as is used for a stove, or stove-grate, or for ventilating apartments; it is furnished with a series of spiral thermostatic bars, each bar being fixed fast at the circumference of the circle B C, of the fixed plate of the air-register; and all the bars act in concert at the centre A, of the twining part of the register, by their ends being inserted between the teeth of a small pinion, or by being jointed to the central part of the turning plate by small pins.

Fig. 8 represents another arrangement of this thermostatic apparatus applied to a circular turning register, like the preceding, for ventilating apartments. Two pairs of compound bars are applied so as to act in concert, by means of the links A C, B C, on the opposite ends of a short lever, which is fixed on the central part of the turning plate of the air-register. The two pairs of compound bars A B, are fastened to the circumference of the fixed plate of the turning register, by two sliding rods A D, B E, which are furnished with adjusting screws. Their motion or flexure is transmitted by the links A C, B C, to the turning plate, about its centre, for the purposo of shutting or opening the ventilating sectorial apertures, more or less, according to the temperature of the air which surrounds the thermostatic turning register. By adjusting the screws A D, and B C, the turning register is made to close all its apertures at any desired degree of temperature; but whenever the air is above that temperature, the flexure of the compound bars will open the apertures.

SEA-HORSE.

A SINGULAR machine, called by its inventor *Nautile de Sauvetage*, but which we think merits the more appropriate title of Sea-horse, has been described in a paper laid before the Academy of Sciences by M. Longchamps. "It is intended to aid vessels in distress, however violent the weather, and is stated to be composed of a case of zinc, strengthened with internal arches of wood, of which the perpendicular section is elliptical, and terminated at the bottom with a sort of 'appendix.' Its length is 3½ metres, and its cubic contents about 1600 litres; its top is covered in all its length with a saddle, having as many pair of stirrups as the nautile is intended to carry men, in such a manner that they sit upon this nautile as men on horseback. Six men are placed on the nautile, of which three manage the wheels with palettes in wood or cloth, which have their resistance, not in the water, but in the air. This means of propelling boats has already been put in practice on the Seine, in 1785, with complete success. Behind the nautile is attached a cord, which is veered from the boat, and when the men have reached the shore, they draw, by means of this cord, a cable which they fasten on the shore, and thus enable those on the vessel to reach it." The inventor says, let the wind and weather be what it will, the ship can be reached by the nautile, and should the machine be turned by the violence of the wind or waves on its side, it will, from its construction, soon right itself, and as the men it carries are, as it were, nailed to the saddle, all that they will experience will be a momentary ducking.—*Inventors' Advocate.*

SOLLY'S ELECTRIC THERMOMETER.

(Addressed to the Editor of the Philosophical Magazine.)

SIR.—I am induced to give you the following account of a little thermo-electric arrangement, believing that it may be interesting to some of your readers; for although there is little or no novelty in the principles on which its action depends, I am not aware that it has been before practically employed:—

"I had for some time experienced considerable inconvenience in conducting certain experiments requiring a long-continued and uniform degree of heat, from the difficulty of regulating the temperature of my furnace, and the constant uncertainty whether everything was proceeding satisfactorily during my absence from the laboratory. I had in consequence often thought of the possibility of so arranging a little thermo-electric apparatus that it might serve as an index of the rate of combustion and consequent heat of the furnace, by the deflection of a galvanometer at a distance from the source of heat. A small thermo-electric battery might be so placed that the one series of joints or solderings should be constantly exposed to the heated surface of the furnace; but a serious obstacle presented itself to any contrivance of this kind, which was the difficulty of keeping the alternate joints of the battery cool: a current of electricity would doubtless be evolved in consequence of the difference of temperature existing between the two sides of the battery, but of course as the heat would gradually traverse from the hotter to the cooler side, it would greatly diminish and modify the results, and thus present false indications of temperature; whilst even if it were possible to keep the one side of the battery cool, either by water or by any other means, yet the value of the deflection of the galvanometer would be always uncertain, as the difference between the two sides of the battery could never be ascertained unless the exact reduction of temperature thus caused were correctly known.

"After one or two unsuccessful attempts to overcome this objection, I laid aside the battery and substituted in its place a single pair of metallic elements, which I found gave abundance of power, and was not liable to the defect which the use of the battery involved.

"A piece of copper wire, one twenty-fourth of an inch in diameter, and of sufficient length to reach from the furnace to my ordinary sitting-room, was joined by twisting the ends to a similar wire of soft iron, the ends of both having been previously well cleaned with sand-paper. The two wires were then secured in a convenient manner by small nails to the walls of the rooms they had to pass through, care being taken that they were not anywhere in contact with each other, except at the two extreme points of junction; the one of these was so placed in the flue of the furnace that it was completely exposed to the action of the hot air and smoke at that part where the flue left the body of the furnace, whilst the other joint was in my room in contact with a thermometer, and surrounded with cotton, so as to render it as little as possible liable to sudden changes of temperature. The copper wire was then divided about a foot from the joint thus protected; the two ends of the wire were connected with the extremities of a galvanometer coil, and the apparatus was complete.

"A metallic circuit was thus made consisting of two elements, the one being the iron wire, and the other the copper wire, including the additional length of copper wire in the coil of the galvanometer. The one joint or point of contact was of course always far hotter than the other, and would necessarily remain so, so long as the fuel in the furnace continued to burn, and would be dependent on the rate of combustion in the furnace; whilst the other junction would always remain very nearly at the temperature of the air, and its variations could be readily known by the thermometer in contact with it. A current of electricity was thus generated, proportioned to the difference of temperature between the two joints, and a deflection of the galvanometer was caused, which increased when the furnace became hotter, decreased when it cooled, and at all times indicated accurately the changes of temperature taking place, thus giving me a thermometer which indicates, without my moving from the table, the exact rate of combustion going on in the furnace, which is fifty yards distant from the indicator. I believe that it is commonly supposed that weak thermo-electric currents cannot be well made to traverse small wires of any length, and this is probably the reason why this beautifully manageable power has been so little employed for practical uses. I have received so much satisfaction from the arrangement just described, that I am convinced it would be found a very useful indicator of temperature in stoves, flues, and hot pipes, in many situations where a common thermometer is inapplicable.

"The cost of such an apparatus must necessarily be more expensive than any thermometer, but then it must be remembered that it does far more than an ordinary thermometer, giving us the means of knowing the temperature of a stove or furnace at a distance, giving us indications of the least change or variation in the source of heat, with even greater certainty and distinctness than a thermometer; and besides, showing these changes so rapidly that we know whether it is becoming hotter or colder, before a thermometer placed on the outside of the stove indicates any change. I have observed, on comparing the thermo-electric with an ordinary thermometer placed on the iron plate forming the top of the furnace, that if the ash-pit door were closed, or the draught in any other way diminished, the deflection of the galvanometer was immediately reduced, whilst the external thermometer continued to rise for some little time; and that the indications given by the galvanometer of the augmentation or decrease of temperature in the furnace, always preceded the same indications from the mercurial thermometer on the top."

THE ORGAN OF TASTE.

BY M. DONOVAN, ESQ.

(Resumed from page 256, and concluded.)

In culinary combinations of food, spices and other stimulants are used, not merely for the purpose of imparting their own flavor, but with a view of exciting the organ of taste to the perception of the flavor of the meats, &c. of which they are composed, in a higher degree than it would otherwise have been. It is not the biting quality of pepper alone that is valued; and wine is not used in sauces that its taste, as such, may be perceived. The perfection of the art of making culinary combinations is the production of a *tertium quid*, in which the elementary flavors are all lost and indistinguishable in the new one created by their combined effect on the palate.

When the flavor of an edible substance is very delicate and peculiar, the palate should never be excited by powerful stimuli, either previously or simultaneously; for powerful stimuli act as preparatives to other active ones only. There are many instances of this; the natural flavor of sea-kale, when in highest perfection from a proper soil, is one in which may be distinguished that of the most delicate oyster: if it be peppered, the oyster flavor is entirely lost. Again, a cucumber sliced, moderately salted, and well drained, has a striking admixture of the flavor of a cockle; but this is destroyed as soon as vinegar and pepper are added. If dressed cucumber be eaten at the same time with kidney-beans, the latter lose the whole of their peculiar taste in a singular manner.

The temperature at which impressions are made on the organ of taste is of consequence, because it considerably modifies them. Every one must have remarked that salted meat is much more salt when hot than when cold; and that spices have greater power at a high than a low temperature. A weighed quantity of pepper eaten with an oyster at the freezing temperature, will exert but little energy on the palate, while the same quantity on an equivalent of lobster, heated very hot, will be exceedingly pungent: on this account flavors are often improved by mere increase of temperature; thus very hot coffee is always preferred to the same article when warm: the perfection of a dinner, with most persons, is to have it served as hot as can be; and those who wish for the stimulus of brandy on the palate, without its intoxicating effect, drink it much diluted, but at a scalding heat. Delicate flavors are not appreciated at high heats: thus the finer kinds of tea do not bear to be drawn at a heat above 110° without loss.

A very low temperature is always unfriendly to the perceptions of tastes, and even pungent ones often become insipid. This is strongly exemplified in a circumstance stated by Captain Parry:—A party, that had lost their way in Melville Island during an intense cold, observed that a mixture of rum and water "appeared perfectly tasteless and clammy." The best household bread, if reduced to the temperature of 28°, will be found tasteless in the mouth: it has its best flavor at 60°. To most persons an oyster is in its most agreeable state when raw: at the temperature of 70° or 80° it is not in perfection, the want of sufficient coldness is quite perceptible: yet at 32° it is just as bad, and quite inferior to the same oyster at 48°. I was led to make this trial by reading a passage in Pliny, where he says, that the Romans cooled their oysters with ice: to me it appears that 48° is the temperature best calculated to develope the flavor.

A draught of cold spring-water is delightful in summer, not merely on account of its coldness but on account of its apparent freedom from all ill taste. Here the organ judges under the deceptive and paralysing influence of cold; for let some of the same water rise to the temperature of 70°, and it will evince that it not only possessed a taste but a disagreeable one. Scarcely any water that issues directly from springs is free from a mineral flavor, and this is chiefly disguised by its coldness.

Some kinds of bad port wine are improved by icing: for the reduction of temperature renders the organ less sensitive. The same treatment would virtually lessen the fine flavor of good port; and hence such ought not to be iced. To reduce good port to 32° would not only render it muddy, because a salt, consisting of lime, potash, and tartaric acid, would be precipitated, but it would lock up its flavor, as it is expressed: it may, however, be advantageously cooled down to 45° or 50°; for then the proper degree of sapidity is developed. Madeira and wines of great body bear a slight elevation of temperature; and suffer an agreeable developement of flavor; sparkling Champagne, on the other hand, is improved by cold, for it then better retains its carbonic acid when poured out; and, although in this state it effervesces less briskly in the glass, the taste of the carbonic acid, one of its important constituents, is rendered more perceptible. But even of this wine much icing locks up the flavor.

In some instances the desired effect is produced by reducing the temperature of part of the mouth, instead of cooling the liquor. The taste of porter is best at a medium temperature: in warm weather it is considered, by persons who are fastidious in that beverage, to be improved by being drunk out of a metallic vessel. The metal, being an excellent conductor of heat, on being applied to the lips causes an instantaneous rush of heat from all parts to restore the equilibrium, and the porter is received into the mouth while the nerves are at a lower temperature; and therefore the liquor tastes to more advantage. At least this is as good a theory as that which has been long since advanced, in which the improvement of porter drunk out of a metallic vessel is attributed to the agency of galvanism. So sensitive is the organ of taste in this respect, that if the liquor be covered by a foamy head, which is a very bad conductor of heat, it intercepts the passage of heat from the upper lip, and hence feels warm, and becomes disagreeable whether the vessel is metallic or not.[4]

The organ of smell is allied to the organ of taste, and many analogous phenomena are found to affect the former. In an experiment made by Mr. Boyle, mustard-seed, infused on the juice of apples, afforded so rank a smell of garlic, that no one would drink it; yet neither of these substances has a smell in the slightest degree resembling garlic. I have observed that if one first smells to some highly rectified naphtha, obtained from cannel-coal, and immediately after to some spirit of vegetable tar, equally well rectified, the odour of the latter will appear completely changed, and resemble a perfume in which the scent of lavender is very striking

THE PICTURESQUE IN PAINTING.

"Picturesque beauty," says a late writer on that subject, "refers to such beautiful objects as are suited to the pencil." This term, although principally appropriated to the works of nature, is not misplaced with reference to many of the performances of art. Those objects best merit the appellation (of the former class) which are distributed by the hand of nature with a mixture of grandeur, simplicity, and varied rudeness. A neat ordinary looking garden, for instance, although a cheerful and agreeable object, abstractedly considered, yet displays too great a proportion of uniformity, of laying out of *design*, to be fairly characterized as picturesque. "The ideas of *neat* and *smooth*," observes Mr. Gilpin, "instead of being picturesque, in fact, disqualify the object in which they reside from any pretensions to picturesque beauty. Nay, farther, we do not scruple to assert that roughness forms the most essential point of difference between the beautiful and the picturesque: as it appears to be that particular quality which makes objects chiefly pleasing in painting. We use the general term *roughness*; but, properly speaking, roughness relates only to the surface of bodies; when we speak of their delineation we use the term *ruggedness*. Both ideas, however, equally enter into the picturesque, and both are observable in the smaller as well as in the larger parts of nature; in the outline and bark of a tree, as in the rude summit and craggy sides of a mountain.

"Let us then examine our theory by an appeal to experience, and try how far these qualities enter into the idea of picturesque beauty, and how far they mark that difference among objects which is the ground of our inquiry.

"A piece of Palladian architecture may be elegant in the last degree; the proportion of its parts, the propriety of its ornaments, and the symmetry of the whole, may be highly pleasing; but if we introduce it into a picture, it immediately becomes a formal object, and ceases to please. Should we wish to give it picturesque beauty, we must use the mallet instead of the chisel: we must beat down one half of it, deface the other, and throw the mutilated members around in heaps; in short, from a smooth building we must turn it into a rough ruin. No painter who had the choice of the two objects would hesitate a moment.

"Again, why does an elegant piece of garden ground make no figure on canvass?—The shape is pleasing, the combination of the objects harmonious, and the winding of the walk in the very line of beauty. All this is true; but the smoothness of the whole, though right and as it should be in nature, offends in picture. Turn the lawn into a piece of broken ground, plant rugged oaks instead of flowering shrubs, break the edges of the walk, give it the rudeness of a road, mark it with wheel tracks, and scatter around a few stones and brushwood; in a word, instead of making the whole smooth, make it rough, and you make also it picturesque. All the other ingredients of beauty it already possessed."

Picturesque composition may be defined, to speak generally, as the art of uniting, in one whole, a variety of parts, which parts may be sought and found among the works of art, (though in a far less proportion,) as well as in the works of nature. Objects may likewise be *made* picturesque: this, however, is hazardous work, and there is no small danger of missing the picturesque, and falling into the ridiculous. *Artificial ruins*, for example, can seldom be regarded as matters of good taste; and when the trick is known, the eye, or rather the imagination, through the medium of the eye, refuses to recognize therein any of the principles of romantic beauty sought to be imparted. The great source of picturesque beauty is nature in all her original variety and irregular grandeur. "We seek it," says the ingenious authority quoted above, "among all the ingredients of landscape—trees, rocks, broken grounds, woods, rivers, lakes, plains, valleys, mountains, and distances. These objects, in themselves, produce infinite variety; no two rocks or trees are exactly the same—they are varied a second time by combination, and almost as much a third time by different lights and shades, and other aerial effects. Sometimes we find among them the exhibition of a whole, but oftener we find only beautiful parts."

Grandeur or sublimity, unassisted, cannot elevate an object to the character of picturesque; however grand the mountain or rock may be, it has no claim to this epithet, unless its form, its color, or its accompaniments have some degree of beauty. Nothing can be more sublime than the ocean; but, wholly unaccompanied, it has little of the picturesque. When we talk, therefore, of a sublime object, we always understand that it is also beautiful; and we call it sublime or beautiful only as the ideas of sublimity or simple beauty prevail. But it is not only the form and composition of the objects of landscape which the picturesque eye examines: it connects them with the atmosphere; and seeks for all those various effects which are produced from that vast and wonderful storehouse of nature. Nor is there, in travelling, a greater pleasure, than when a scene of grandeur bursts unexpectedly on the eye accompanied with some accidental circumstance of the atmosphere which harmonizes with it and gives it double value.

Few are the places so barren and destitute as to afford nothing from which materials may be extracted by the lover of the picturesque.

The great military road between Carlisle and Newcastle is, perhaps, the most barren tract of country in England: "yet even here," says Gilpin, "there is always something to amuse the eye. The interchangeable patches of heath and greensward make an agreeable variety. Often, too, on these vast tracts of intersecting grounds, we see beautiful lights softening off along the sides of hills; and often we see them adorned with cattle, flocks of sheep, heath-cocks, grouse, plover, and flights of other wild fowl. A group of cattle standing in the shade on the edge of a dark hill, and relieved by a lighter distance beyond them, will often make a complete picture, without any other accompaniment. In many other situations, also, we find them wonderfully pleasing, and capable of making pictures amidst all the deficiencies of landscape. Even a winding road itself is an object of beauty; while the richness of the heath on either side, with the little hillocks and crumbling earth, give many an excellent lesson for a foreground. When we have no opportunity of examining the grand scenery of nature, we have, at least, everywhere the means of observing with what a multiplicity of parts, and yet with what a general simplicity, she covers every surface.

"But if we let the imagination loose, even scenes like these administer great amusement. The imagination can plant hills, can form rivers and lakes in valleys, can build castles and abbeys, and, if it find no other amusement, can dilate itself in vast ideas of space."

STRENGTH OF MATERIALS.

(*From Arnott's "Elements of Physics."*)

"STRENGTH depends on the magnitude, form and position of bodies, as well as on the degree of cohesion in the material."

Of similar bodies the largest is proportionally the weakest.—Suppose two blocks of stone left projecting from a rock that has been hewn, of which blocks one is twice as long, and deep, and broad as the other. The larger one will by no means support as much more weight at its end than the other, as it is larger; and for two reasons:—1. In the larger, each particle of the surface of attachment, in helping to bear the weight of the block itself, has to support by its cohesion twice as many particles beyond it, in the double extent of projection, as a particle has to support in the shorter block;—and, 2, both the additional substance, and anything appended at the outer extremity of the larger, are acting with a double lever advantage to break it, that is, to destroy the cohesion. Hence, if any such projection be carried out very far, it will break off or fall by its own weight alone. What is thus true of a block supported at one end, is equally true of a block supported at both ends; and, indeed, of all masses, however supported, and of whatever forms. That a large body, therefore, may have proportionate strength to a smaller, it must be made still thicker and more clumsy than it is made longer; and, beyond a certain limit, no proportions whatever will keep it together, in opposition merely to the force of its own weight. This great truth limits the size and modifies the shape of most productions of nature and of art,—of hills, trees, animals, architectural or mechanical structures, &c.

Hills.—Very strong or cohesive material may form hills of sublime elevation, with very projecting cliffs and very lofty perpendicular precipices; and such are seen, accordingly, where the hard granite protrudes from the bowels of the earth, as in the Andes of America, the Alps of Europe, the Himalayas of Asia, and the Mountains of the Moon in Central Africa. But material of inferior strength exhibits more humble risings and more rounded surfaces. The gradation is so striking and constant from granite mountains down to those of chalk, or gravel, or sand, that the geologist can generally tell the substance of which a hill is composed by the peculiarities of its shape. Even in granite itself, which is the strongest of rocks, there is a limit to height and projection; and if an instance of either, much more remarkable than now remains on earth, were by any chance to be produced again, the law which we are considering would prune the monstrosity. The grotesque figures of rocks and mountains seen in the paintings of the Chinese, or actually formed in miniature for their gardens, to express their notions of perfect sublimity and beauty, are caricatures of nature, for which originals can never have existed. Some of the smaller islands in the Eastern ocean, however, and some of the mountains of the chains seen in the voyage towards China, along the coasts of Borneo and Palawan, exhibit, perhaps, the very limits of possibility in singular shapes. In the moon, where the weight of gravity of bodies is less than on the earth, on account of her smaller size, mountains might be many times higher than on the earth; and observation proves that the lunar mountains are much higher than ours. By the action of winds, rains, currents, and frost upon the mineral masses around us, there is unceasingly going on an undermining and wasting of supports, so that every now and then immense rocks, or almost hills, are torn by gravity from the station which they have held since the earth received its present form, and fall in obedience to the law now explained.

The size of vegetables, of course, is obedient to the same law. We have no trees reaching a height of 300 feet, even when perfectly perpendicular, and sheltered in forests that have been unmolested from the beginning of time; and oblique or horizontal branches are kept within very narrow limits by the great strength required to support them. The truth that, to have proper strength, the breadth or diameter in bodies must increase more quickly than the length, is well illustrated by the contrast existing between the delicate and slender proportions of a young oak or elm, while yet in the seedsman's nursery, and its sturdy form when it has braved for centuries all the winds of heaven, and has become the monarch of the park or forest.

Animals furnish other interesting illustrations of this law. How massive and clumsy are the limbs of the elephant, the rhinoceros, the heavy ox, compared with the slender forms of the stag, antelope, and greyhound! And an animal much larger than the elephant would fall to pieces from its own weight alone, unless its bones were made of much stronger materials. Many have questioned whether the mammoth, or antediluvian elephant, could have lived on dry land, or must have been amphibious, that its great body might generally be borne up by water. The whale is the largest of animals, but feels not its mighty weight because lying constantly in the liquid support of the ocean. A cat may fall with impunity where an elephant or ox would be dashed to pieces. The giants of the heathen mythology could not have existed on this earth, for the reason which we are now considering; although on our moon, where, as already stated, weight is much less, such beings might be. In the planet Jupiter, again, which is many times larger than the earth, an ordinary man from hence would be carrying, in the simple weight of his body, a load sufficient to crush the limbs which supported him. The phrase *a little compact man*, points to the fact that such a one is stronger in proportion to his size than a taller man. The same law limits the height and breadth of architectural structures. In the houses of fourteen stories, which formerly stood under the castle of Edinburgh, there was danger of the superincumbent wall crushing the foundation.

Roofs.—Westminster hall approaches the limit of width that is possible without very inconvenient proportions or central supports; and the domes of the churches of St. Peter, in Rome, and St. Paul, in London, are in the same predicament.

Arches of a Bridge.—A stone arch much larger than those of the magnificent bridges in London, would be in danger of crushing and splintering its material.

Ships.—The ribs of timbers of a boat have scarcely a hundredth part of the bulk of the timbers of a ship ten times as long as the boat. A ship's yard of ninety feet contains, perhaps, twenty times as much wood as a yard of thirty feet, and, even then, is not so strong in proportion. If ten men may do the work of a three-hundred-ton ship, many more than three times that number will be required to manage a ship three times as large. Very large ships, such as the two built in Canada in the year 1825, which carried each nearly 10,000 tons, were weak from their size alone; and the loss of these two first specimens of gigantic magnitude will not encourage the building of others like them.

(To be continued.)

PRESERVATION OF BOOKS FROM INSECTS.

The *Societé des Bibliophiles* of Hainault have offered a gold medal, worth one hundred francs, to the author of the best memoir forwarded to the society, in answer to the following question: "What are the best means of totally preventing the ravages of the insects which destroy books?" The condition annexed to the success of the paper is, that the means proposed may be applied easily, and at little expense to all libraries large or small.

It seems to us, that in making this proposal, the society has not reflected that it will give a very difficult task to the commission appointed to decide on the merit of the different papers sent in. Let us suppose that several persons recommend each a different process. How is the society to test the respective value of these communications; how are they to judge if they are suitable, or if they fulfil exactly the object proposed? The ravages of insects in books are never instantaneous; it is only after the lapse of some time, more or less long, that it is possible to perceive traces of them on the paper.

We are convinced that essential oils and strong perfumes would preserve a book for a length of time from the cause of destruction, to which the question of the society refers; but to be assured of the continued existence of these perfumes would require an observation of many years.

Amongst the means of preservation which appears to us best, we may cite the following:—1. To introduce in every volume some leaves of an herb, of small expense, and strong and penetrating smell. 2. To submit the books to the vapour of essential oils in a state of ebullition. 3. To line the interior of the covers of every book with sheets of tanned sheepskin or paper, in the preparation of which use should be made of substances of a strong odoriferous smell, and in the course of time to rebind them with materials of a similar description.

As we are on the subject of the preservation of books, it appears to us, that the printers of the present day do not work for posterity; for they employ a species of paper containing a germ of destruction, which, although it acts slowly, is not the less certain in effect. We allude to the chloride of which use has been made for some years, for the purpose of whitening the pulp, which serves to prepare the different sorts of paper intended, as well for printing, as for ordinary use.

This strong agent not only takes from the paper a portion of the strength which it possessed under the old process of bleaching, and which may easily be perceived by comparison of the paper of our modern books, which can be easily torn, with the tough paper of the books of the last century; but it also enters into intimate combination with the pulp, and this union will have the effect of reducing to powder in the course of twenty years the books of the present day.—*Le Fanal.*

ATMOSPHERIC REFRACTION AND REFLECTION.

Not only every thing we hear, but all we see, is through the medium of the atmosphere. Without some knowledge of its action upon light, it would be impossible to ascertain the position of the heavenly bodies, or even to determine the exact place of very distant objects upon the surface of the earth; for, in consequence of the refractive power of the air, no distant object is seen in its true position.

All the celestial bodies appear to be more elevated than they really are; because the rays of light, instead of moving through the atmosphere in straight lines, are continually inflected towards the earth. Light passing obliquely out of a rare into a denser medium, as from vacuum into air, or from air into water, is bent or refracted from its course towards a perpendicular to that point of the denser surface where the light enters it. In the same medium, the sine of the angle contained between the incident ray and the perpendicular is in a constant ratio to the sine of the angle contained by the refracted ray and the same perpendicular; but this ratio varies with the refracting medium. The denser the medium, the more the ray is bent. The barometer shows, that the density of the atmosphere decreases as the height above the earth increases. Direct experiments prove, that the refractive power of the air increases with its density. It follows, therefore, that if the temperature be uniform, the refractive power of the air is greatest at the earth's surface and diminishes upwards.

A ray of light from a celestial object falling obliquely on this variable atmosphere, instead of being refracted at once from its course, is gradually more and more bent during its passage through it, so as to move in a vertical curved line, in the same manner as if the atmosphere consisted of an infinite number of strata of different densities. The object is seen in the direction of a tangent to that part of the curve which meets the eye, consequently the apparent altitude of the heavenly bodies is always greater than their true altitude. Owing to this circumstance, the stars are seen above the horizon after they are set, and the day is lengthened from a part of the sun being visible, though he really is behind the rotundity of the earth. It would be easy to determine the direction of a ray of light through the atmosphere, if the law of the density were known; but as this law is perpetually varying with the temperature, the case is very complicated. When rays pass perpendicularly from one medium into another, they are not bent; and experience shows, that in the same surface, though the sines of the angles of incidence and refraction retain the same ratio, the refraction increases with the obliquity of incidence. Hence it appears, that the refraction is greatest at the horizon, and at the zenith there is none. But it is proved that at all heights above ten degrees, refraction varies nearly as the tangent of the angular distance of the object from the zenith, and wholly depends upon the heights of the barometer and thermometer. For the quantity of refraction at the same distance from the zenith, varies nearly as the height of the barometer, the temperature being constant; and the effect of the variation of temperature is to diminish the quantity of refraction by about its 180th part for every degree in the rise of Fahrenheit's thermometer. Not much reliance can be placed on celestial observations within less than ten or twelve degrees of the horizon, on account of irregular variations in the density of the air near the surface of the earth, which are sometimes the cause of very singular phenomena. The humidity of the air produces no sensible effect on its refractive power.

Bodies, whether luminous or not, are only visible by the rays which proceed from them. As the rays must pass through strata of different densities in coming to us, it follows that, with the exception of stars in the zenith, no object either in or beyond our atmosphere is seen in its true place. But the deviation is so small in ordinary cases, that it causes no inconvenience, though in astronomical and trigonometrical observations due allowance must be made for the effects of refraction. Dr. Bradley's tables of refraction were formed by observing the zenith distances of the sun at his greatest declinations, and the zenith distances of the pole-star above and below the pole. The sum of these four quantities is equal to 180°, diminished by the sum of the four refractions, whence the [illegible]f the four refractions was obtained; and from the law of the variation of refraction determined by theory, he assigned the quantity due to each altitude. The mean horizontal refraction is about 35′ 6″, and at the height of forty-five degrees it is 58″·36. The effect of refraction upon the same star above and below the pole was noticed by Alhazen, a Saracen astronomer of Spain, in the ninth century, but its existence was known to Ptolemy in the second, though he was ignorant of its quantity.

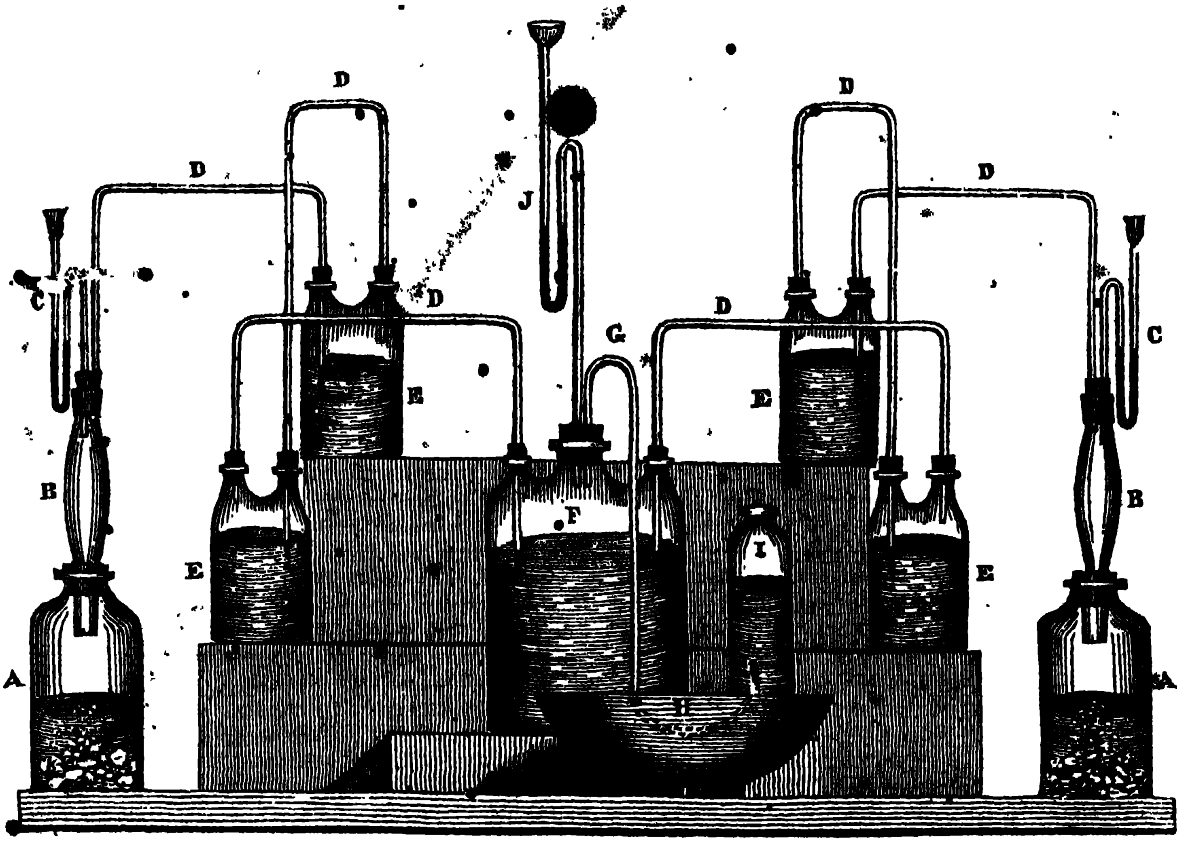
The refraction of a terrestrial object is estimated differently from that of a celestial body. It is measured by the angle contained between the tangent to the curvilineal path of the ray, where it meets the eye, and the straight line joining the eye and the object. Near the earth's surface, the path of the ray may be supposed to be circular; and the angle at the centre of the earth corresponding to this path is called the horizontal angle. The quantity of terrestrial refraction is obtained, by measuring contemporaneously the elevation of the top of a mountain above a point in the plain at its base, and the depression of that point below the top of the mountain. The distance between these two stations is the chord of the horizontal angle; and it is easy to prove that double the refraction is equal to the horizontal angle, increased by the difference between the apparent elevation and the apparent depression. Whence it appears that, in the usual state of the atmosphere, the refraction is about the fourteenth part of the horizontal angle.

(To be continued.)

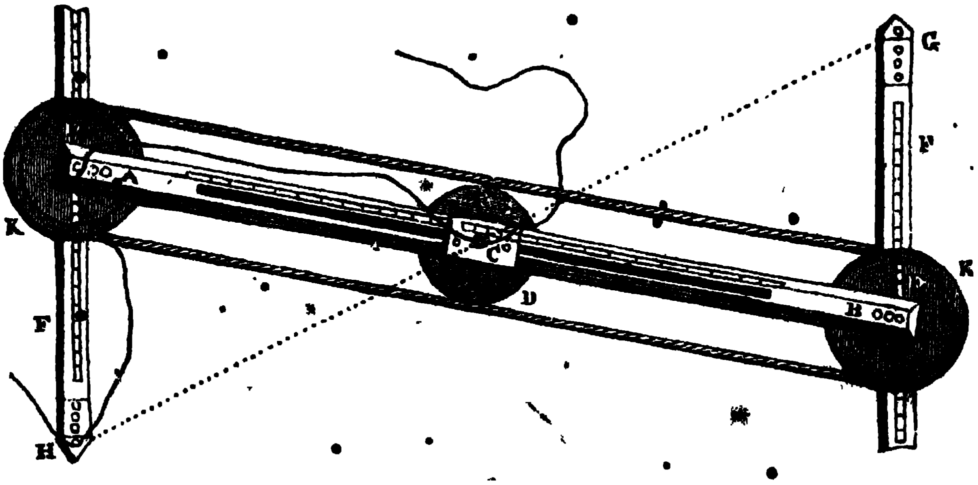
APPARATUS FOR INCREASING THE ILLUMINATING POWER OF COAL GAS.

BY J. W. TAYLOR.

Carburetted hydrogen it is well known owes nearly all its illuminative power to the accidental admixture of a certain oily vapour, which is given off during the decomposition of the coal in the retorts: being aware of this, it occurred to me, that if the gas could be more strongly impregnated with a similar compound, the flame would be increased in intensity, which I afterwards found to be the case. The apparatus consists of a brass reservoir, or chamber, attached to the end of the gas pipe, near the burner; this reservoir may be in the shape of an oil-flask, made air-tight with a screw joint, or other means of supplying any highly volatile oil, turpentine or mineral naphtha, and should be kept about half full; into this reservoir the gas pipe ascends a little above the surface of the oil; a very small jet pipe of gas regulated by a stopcock, is branched off below this chamber, so as to cause a sufficient evaporation of the oil to unite with the gas in the flask receiver: the whole is, of course, surmounted with the usual burner and lamp glass. By employing this apparatus for burning coal gas, the intensity of the flame will be very considerably augmented, consequently the same degree of light may be obtained with a far less consumption of gas, a point which I consider of some importance. It may also be employed for burning those varieties of gas, by the decomposition of several of the anthracites, bituminous earths, woods, &c., which would not be otherwise employed with any advantage for the purpose of illumination. The apparatus might be manufactured at a very trifling cost, being very compact and neat in appearance.—*Chemist.*



IMPREGNATING WATER WITH CARBONIC ACID GAS.



WALLACE'S EIDOGRAPH.

IMPREGNATING WATER WITH CARBONIC ACID GAS.

We have already, in Volume II, given several contrivances for this purpose as used among us; we give the present as the French method of accomplishing the same purpose. A mere description and reference to the apparatus will be all that sufficient to render it intelligible. The two bottles A and A, seen on the sides of the apparatus, contain chalk and oil of vitriol. These bodies, as is well known, act chemically upon each other. The chalk, which is a carbonate of lime, becomes decomposed, parts with its carbonic acid, and its lime unites with the sulphuric acid, forming a sulphate of lime; the carbonic acid being gaseous, rises and remains in the upper part of the bottle, but as an infinitely greater quantity is liberated than can be contained in the bottle, it passes off through a tube B, and from that into a second tube D, and along it into a second bottle E, which is partly filled with water. The gas being soluble in water is rapidly absorbed by it in this vessel, until the water becomes charged with the gas, that is, until it can take up no more; when this is the case, it, instead of being absorbed, passes up the second pipe D into the lower vessel E. The same thing again occurs here as in the former vessel, and when the water in this lower vessel is in like manner charged, the gas will proceed onwards by the third tube D into the bottle F, charging this also; finally it passes along the pipe G, beneath water in the basin H, into the air-jar I, whence it may be removed for use as collected. The reason there are several jars is, that the gas before it can reach I must pass through the water of three vessels, and it becomes thereby very pure and cool. The apparatus is to be considered double, one side of the cut corresponding to the other. Also there are three safety tubes attached to various parts, marked C C J; these are bent tubes of glass, having a few drops of mercury poured into them to prevent the passage of air inwards; their use is to prevent bursting of any part of the apparatus by too great pressure of the gas arising from its rapid formation.

WALLACE'S EIDOGRAPH.

It is a fact well known, that artists of various descriptions, who have frequent occasion to imitate original designs, have long felt the want of convenient mathematical instruments, by which a copy may be made with neatness and expedition, that shall have any given proportion to the original. The pantograph is the only instrument that has been hitherto employed; but although correct and plausible in theory, in practice it is found to be so very imperfect, that the artist hardly ever thinks of making use of it.

A consideration of the essential service that would rendered to the graphic art, by a copying instrument, which should be at once simple in its theory, and easy in its application, induced Mr. Wallace, Professor of Mathematics, at Edinburgh, to turn his attention to the subject; and some years ago he produced a model of a copying instrument, which he denominated an eidograph. The instrument, and its application to the copying of a very great variety of subjects, having been shown to engineers, engravers, and other competent judges in London and in Edinburgh, their opinion of its utility has been such as to leave no doubt of its completely fulfilling the views of the inventor.

The instrument is represented in Fig. 2. The beam A B, which is made of mahogany, slides backward and forward in a socket C: the socket turns on a vertical axis, supported by the fulcrum D, which stands on a table. There is a slit in the beam, through which the axis of the socket passes, so that when the beam slides in the socket, a portion of it passes on each side of the axis. There are two equal wheels E E below the beam, which turn on axes that pass through pipes fixed at A B, near its extremities; and a steel chain passes over the wheels as a band, by which a motion of rotation may be communicated from the one to the other. There are two arms F F, which slide in sockets along the lower face of the wheels, just under their centres: at the extremity G of one arm, there is a metal tracer, with a handle attached to it, by which its points may be carried over the lines in any design; and at H, the extremity of the other arm, there is a black-lead pencil fixed in a metal tube, which is ground to fit so exactly into a pipe so as just to slide up or down. In using the instrument, the pencil in its tube is raised by a thread which passes over a pulley, and it descends again by a weight with which it is loaded.

From the perfect equality of the wheels, it is easy to see, that if the arms attached to them be placed parallel in any one position, they will retain their parallelism, although one of the wheels, and consequently both, be turned on their centres. Supposing, now, that B C and A C, the parts into which the axis is divided at the centre, have any proportion whatever to each other, if the distances of the tracing point G, and pencil point H, from the centres of their wheels have the very same proportion, then it follows from the elements of geometry, that the tracing point G, the centre C, and the pencil point H, will be in a straight line; and further, that C G, and C H, the distance of these points from the centre, will have to each other the constant proportion of C B to C A, or of E G to A H. Such being the geometrical property of the eidograph, if any subject to be copied be fixed to the table on which the instrument stands, and the tracing point be carried over every line of the design, the pencil point will trace a copy in all respects similar to the original. To facilitate the adjustment of the instrument, so that the copy may have any given ratio to the original, there are scales of equal parts on the beam and the two arms. By these and verniers, both halves of the beam, and equal lengths on the arms, are each divided into one thousand equal parts, and, at certain intervals, corresponding numbers are marked on them. By means of the scales, when any ratio is assigned, the adjustment is made without the least difficulty.

To avoid any derangement by the chain slipping on the wheels, there are clamps at K and K, which hold it fast to the wheels at points where it never quits them. They are slackened when the instrument is adjusted.

ALLOYS OF STEEL WITH SILVER.

Besides the various processes that have been adopted ostensibly with the design of improving the quality of pure steel, an almost equal number of attempts have been made to alloy it with other substances, with which, really or in pretence, it has been found chemically to combine. These projects have given rise to a variety of specious appellations, at the best harmless, when applied to mere superiority in the article professedly manufactured from factitious steel, the real excellence of which, if it have any, the common refiner knows must depend entirely upon his old-fashioned operations skilfully performed. Two eminent chemists make and publish a series of experiments, by which it is demonstrated, that a small portion of various of the precious metals might be mixed, by fusion, with the substance of steel; the idea of turning the discovery to practical account is promptly caught; and *silver steel*, having the advantage of euphony and novelty, becomes a popular denomination in the market. But as there is some chance of this manufacture being considered as new-fangled, and diversity and competition being the body and spirit of business, another projector turns him to antiquity: every one interested in cutlery having heard of the famous oriental sabres that, while they bent like a switch, were of so stern a temper that they would themselves cut through ordinary irons; so, with tolerably good taste at least, we are greeted with the announcement of *Damascus steel*. Silver, however, is an ingredient within the reach of every manufacturer who chooses to put it into his melting pot; and Damascus being a somewhat equivocal epithet, at best applying rather to a mode than a material of steel-making; a third party procures from abroad a few lumps of the celebrated Indian *wootz*, a substance which not many persons have seen, and still fewer thoroughly understand, and under these auspices comes forth *Peruvian steel*. Each of these materials may be of acknowledged goodness and celebrity; but at all events they must alike be content with the common credit of an earthly origin: not so, however, with those ferruginous masses which have, at different times, fallen from the clouds. Poetry and policy unite to favor the notion that iron smelted in ether, and hardened in the north wind, must needs, like Homer's horses begotten of the latter agent, be of excellent temper; accordingly, *meteoric steel* has been among the discoveries which have claimed the approbation of the public. We have taken the liberty to introduce, thus playfully, four denominations of factitious steel, which, when recommended as superior to pure steel, for fine cutlery in general, deserve to be treated in no graver style: as connected, however, with metallurgic phenomena, the processes developing those peculiarities of elementary chemical combination, or mechanical structure, upon which the obvious characteristics of the above-named steels are assumed to depend, are far from being uninteresting to the experimentalist.

Attempts to combine iron with silver have at various times been made. The experiments of a French chemist, M. Guyton, as published in the "Annales de Chimie," were deemed so satisfactory to the operator, that he concludes his detail in these terms: "Thus the iron was here alloyed with the silver even in greater quantity than the silver with the iron. Iron can, therefore, no longer be said to refuse to mix with silver; it must, on the contrary, be acknowledged that those two metals brought into perfect fusion, contract an actual chemical union; that, whilst cooling, the heaviest, and, at the same time, the most fusible metal, separates for the greatest part; that notwithstanding each of the two metals retains a portion of the other, as is the case in every liquation; that the part which remains is not simply mixed or interlaid, but chemically united; lastly, that the alloy in these proportions possesses peculiar properties, particularly a degree of hardness that may render it extremely useful for various purposes."

A few years ago, Messrs. Stodart and Faraday made a series of experiments on the alloys of iron and steel at the laboratory of the Royal Institution, the results of which are subsequently published in the "Journal of Arts and Sciences." From the account referred to it appears, that not only silver, but platinum, rhodium, gold, nickel, copper, and even tin, have an affinity for steel sufficiently strong to make them combine *chemically* according to the import of this notice, though only *mechanically* in the opinion of some persons. With respect to the alloy of silver, there are, according to the testimony of the experimentalists mentioned above, some very curious circumstances attending it. If steel and silver be kept in fusion together for a length of time, an alloy is obtained, which appears to be very perfect while the metals are in a fluid state; but on solidifying and cooling, globules of pure silver are expressed from the mass, and appear on the surface of the button. If an alloy of this kind be forged into a bar, and then dissected by the action of dilute sulphuric acid, the silver appears, not in combination with the steel, but in threads throughout the mass, so that the whole has the appearance of a bundle of fibres of silver and steel, as if they had been united by welding. The appearance of these silver fibres is very beautiful; they are sometimes one-eighth of an inch in length, and suggest the idea of giving mechanical toughness to steel, where a very perfect edge may not be required.

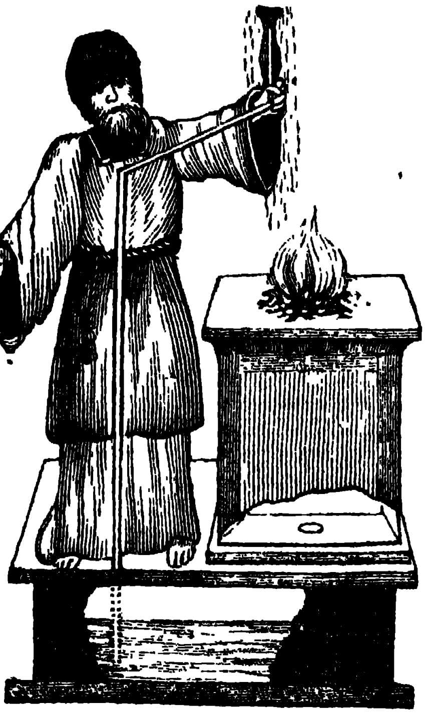
At other times, when silver and steel have been very long in a state of perfect fusion, the sides of the crucible, and frequently the top also, are covered with a fine and beautiful dew of minute globules of silver; this effect can be produced at pleasure. At first the operators were unsuccessful in detecting, by means of chemical tests, the presence of silver in the metallic button; and considering the steel to be uniformly improved, they were disposed to attribute its excellence to the effect of the silver, or to a quantity too small to be tested. By subsequent experiments, however, they were able to detect the silver, even to less than one part in five hundred.

"In making the silver alloys, the proportion first tried was 1 silver to 160 steel; the resulting buttons were uniformly steel and silver in fibres, the silver being likewise given out in globules during solidifying, and adhering to the surface of the fused button; some of these, when forged, gave out more globules of silver. In this state of mechanical mixture the little bars, when exposed to a moist atmosphere, evidently produced voltaic action; and to this we are disposed to attribute the rapid destruction of the metal by oxydation; no such destructive action taking place when the two metals are chemically combined. These results indicated the necessity of diminishing the quantity of silver, and 1 silver to 200 steel was tried. Here, again, were fibres and globules in abundance; with 1 to 300 the fibres diminished, but still were present; they were detected even when the proportion of 1 to 400 was used. The successful experiment remains to be named. When 1 of silver to 500 steel were properly fused, a very perfect button was produced; no silver appeared on its surface; when forged and dissected by an acid, no fibres were seen, although examined by a high magnifying power. The specimen forged remarkably well, although very hard; it had, in every respect, the most favorable appearance. By a delicate test every part of the bar gave silver. This alloy is decidedly superior to the very best steel; and this excellence is unquestionably owing to combination with a minute portion of silver. It has been repeatedly made, and always with equal success. Various cutting tools have been made from it of the best quality. This alloy is, perhaps, only inferior to that of steel with rhodium; and it may be procured at a small expense; the value of silver, where the proportion is so small, is not worth naming; it will probably be applied to many important purposes in the arts."

STEAM AND THE STEAM ENGINE.

Resumed from page 245.

The properties of steam are now so generally known, that it seems almost impossible that mankind should have remained ignorant of its power for so many ages, particularly upon the reflection that they were, even from the first period of civilization, acquainted with many of the uses of fire, in smelting and working metals, cooking victuals, heating water for baths, and other purposes, some of which must of necessity have taught them that water rises into steam by heat, and condenses again by cold. It is even said that Papin, the real inventor of the steam engine, had his attention drawn to the power of vapor by observing the lid of his tea kettle fly off. Be this anecdote true or not, it is certain that steam, as a motive power, applicable to useful purposes, was not previously thought of; still this fact is to be taken with some little reservation, as it is known that two or three philosophical toys, acting by steam, were previously known, and others acting by the expansive force of confined air were still more common; and in one instance this expansive force was made subservient to impose upon the religious credulity of a people. We allude, of course, to Hero's altar, a contrivance of considerable ingenuity, and which may be thus described:—

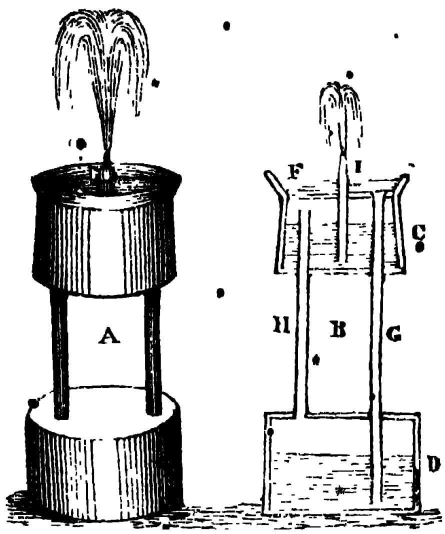


A square pedestal, like an altar in shape, made air tight and hollow, the top of it being of thin metal, was connected with another and a wider vessel at the foot; there being a hole between the two vessels. The lower vessel was nearly filled with oil. The figure of a priest stood by the side of the altar, with his arm extended, and holding in his hand a vase; a small pipe was concealed within the body of the figure, and extended from the bottom of the vase (communicating with it) along the arm, down the body, and into the lower vessel, where it dipped beneath the surface of the oil. When a fire was lighted upon the altar, the air within it was rarefied, and consequently pressed upon the surface of the oil, driving it up the tube, and not merely filling the vase, but even running over on to the fire, and therefore increasing the flames. This increase of the fire produced of necessity a farther rarefication of the air, and a fresh supply of oil, until the whole contents of the under vessel were exhausted, or rather until the air could get into the pipe belonging to the image.

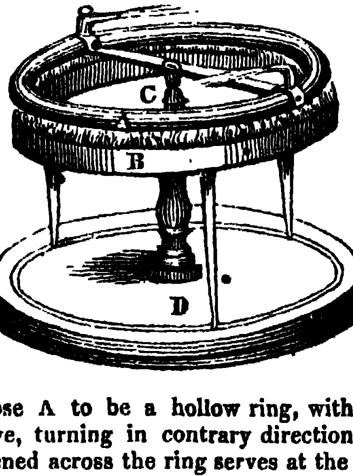
That which suggested the following apparatus was, most probably, the statue of Memnon, recorded to have emitted sounds, which were ascribed to the interposition of super-human agency, said in after times to have been produced by *vapor rising from water*, concealed in a cavity of the statue, being made to pass through a tube, having a small orifice fashioned in a manner similar to that of the pipe of an organ. As long as the fluid was heated by the rays of the sun, mysterious sounds were heard by the assembled worshippers, which died gradually away as the solar influence was withdrawn from the gigantic idol. This explanation is ascribed to Hero himself; and is to be found in his "Pneumatica." The subject has exercised the ingenuity of other writers. Among the moderns, Solomon De Caus and Kircher, Porta, Branca, Cardan, and others. That the above could not have been the cause of the sounding of Memnon's statue must be evident, because the sun's heat was not sufficient to raise the water in vapor, or in other words to raise it to a height of 212° of heat; but as in the case of Hero's altar, the rarefied air rushing out might have produced a noise, it passing through a properly-constructed orifice.

Tried by the high standard of even modern attainment, several of the machines invented by Hero may be compared with the most useful, or the most ingenious, of those which have been appealed to as proud monuments, placing our own age at an immense distance beyond every other in mechanical invention. The fountain for raising water by the compression of air remains as he left it. As this has a close connection with several machines which are to follow, we briefly describe it.

One figure shows the external appearance, the other the internal section. There are three vessels, two of them inclosed; as C D, and one of them open at the top, as F. A pipe G extends from F, through C into D, where it reaches nearly to the bottom. A second pipe H passes from nearly the top of C through the bottom of C, and into the top of D. A third pipe proceeds into the vessel C, and upwards into the air. When water is poured into F, it passes down the pipe G, supplying D with more water, the air within it is driven up the pipe H into C. The condensation that here takes place drives the water up the centre pipe, from the top of which it issues in a jet. The effect here, proceeding as it does from the sole pressure of the short column of water in G, could have been but trifling; but when Hero employed the force of fire, as in his altar, then it became an instrument which, though perhaps not useful in itself, yet was acted upon by a force capable of being used to any extent, as it has since been, and if its applications at a former period were trivialities rather than useful instruments, still they formed a foundation upon which to rest the calculations and experiments of later philosophers.



Hero describes thirteen machines which operate by the action of heat on air and water. In two the doors of a temple are opened and shut by means of the rarefaction of air; in another, water or wine is raised by the same means; in another this is combined with the hissing of a dragon; and a rotatory motion is in another imparted to a small stage, on which automata are placed. In some of these, from the construction of the apparatus, steam of low pressure would be produced, and assist in the action. But throughout it is not quite obvious that Hero had a notion of the distinction between the heated air and the vapor, or rather he considered that the vapor owed its power to the *heated air* with which it was combined or mixed. The method of giving motion to a vessel by means of steam, deserves attention, as it is the origin of all the numerous Æolipiles, which have since been invented. Three of these instruments were described in the "Magazine of Science," (Vol. II, page 308,) the first of which is one of those given by Hero; we will therefore not re-describe it, but rather show another kind constructed at a later period, but upon precisely the same principles



Suppose A to be a hollow ring, with two bent jets above, turning in contrary directions, a metal bar fastened across the ring serves at the same time to strengthen it, and to support it on a central point or pivot C, round which it may rotate. This ring is nearly filled with water. B is a ring-shaped dish or trough, filled with tow and tallow, and used instead of a fire, to heat the ring above; D is a footboard to support the whole. When the water in A is heated, the steam will rush out of the jets, and by its action upon the air, or rather by the counter action of the air upon it, will rotate rapidly.

These attempts at employing steam as a mechanical power are described, without even a hint at their extension to any useful purpose. This can detract but little from the merit of Hero, a sagacity little short of prescience could alone have enabled him to anticipate the grandeur of that creation that was to arise from these beautiful, but comparatively insignificant beginnings.

(To be continued.)

STRENGTH OF MATERIALS.

(Resumed from page 263, and concluded.)

The degree in which the strength of structures is dependent on the form and position of their parts, will be illustrated by considering the two cases of longitudinal and transverse compression; and the rule for giving strength will be found to be, to cause the force tending to destroy, to act, as equally as may be, on the whole resisting mass, at the same time, and with as little mechanical advantage as possible. In *longitudinal compression*, as produced by a body on the top of a pillar, the weight, while the support remains straight, can only destroy the support by crushing it in opposition to the repulsion and impenetrability of all its atoms. Hence a very small pillar, if kept perfectly straight, supports a very great weight; but a pillar originally crooked, or beginning to bend, resists with only part of its strength; for the whole weight above is supported on the atoms of the concave side only, which are therefore in greater danger of being overpressed and crushed, while those on the convex side, separated from their natural helpmates, are in the opposite danger of being torn asunder. The atoms near the centre, in such a case, are almost neutral, and might be absent without the strength of the pillar being much lessened. Long pillars or supports are weaker than short ones, because they are more easily bent; and they are more easily bent because a very inconsiderable, and therefore easily affected, yielding between each two of many atoms, makes a considerable bend in the whole; while in a very short pillar, there can be no bending without a great change in the relation of proximate atoms, and such as can be effected only by great force. The weight or force bending any pillar may be considered as acting at the end of a long lever, reaching from the end of the pillar to its centre, against the strength resisting at a short lever from the side to the centre. The strength, therefore, has relation to the difference between these. Shortness, then, or any stay or projection at the side of the pillar, which, by making the resisting lever longer, opposes bending, really increases the strength of a pillar. A column with ridges projecting from it is, on this account, stronger than one that is perfectly smooth. A hollow tube of metal is stronger than the same quantity of metal in a solid rod, because its substance, standing further from the centre, resists with a longer lever. Hence pillars of cast-iron are generally made hollow, that they may have strength with as little metal as possible. In the most perfect weighing-beams for delicate purposes, that there may be the least possible weight with the required strength, the arms, instead of being of solid metal, are hollow cones, in which the metal is not much thicker than writing paper. Masts and yards for ships have been made hollow, in accordance with the same principle. In nature's works, we have to admire numerous illustrations of the same class. The stems of many vegetables, instead of being round externally, are ribbed or angular and fluted, that they may have strength to resist bending. They are hollow, also, as in cornstalks, the elder, the bamboo of tropical climates, &c., thereby combining lightness with their strength. A person who visits the countries where the bamboo grows, cannot but admire the almost endless uses to which its straightness, lightness and hollowness, make it applicable among the inhabitants. Being found of all sizes, it has merely to be cut into pieces of the lengths required for any purpose; and nature has already been the turner, and the polisher, and the borer, &c. In many of the Eastern islands, bamboo is the chief material of the ordinary dwellings, and of the furniture,—the fanciful chairs, couches, beds, &c. Flutes and other wind instruments there are merely pieces of the reed, with holes bored at the requisite distances. Conduits for water are pipes of bamboo; bottles and casks for preserving liquids are single joints of larger bamboo, with their partitions remaining; and bamboo, split into threads, is twisted into rope, &c. From the animal kingdom, also, we have illustrations of our present subject—the hollow stiffness of the quills of birds; the hollow bones of birds; the bones of animals generally, strong and hard, and often angular externally, with light cellular texture within, &c.—*Transverse pressure.* When a horizontal beam is supported at its extremities, its weight bends it down more or less in the middle, the particles on the upper side being compressed, while the parts below are distended; and the bending and tendency to break are greater, according as the beam is longer and its thickness or depth is less. The danger of breaking, in a beam so situated, is judged of by considering the destroying force as acting by the long lever reaching from the end of the beam to the centre, and the resisting force or strength as acting only by the short lever from the side to the centre, while only a little of the substance of the beam on the under side is allowed to resist at all. This last circumstance is so remarkable, that the scratch of a pin on the under side of a plank resting as here supposed, will sometimes suffice to begin the fracture. Because the resisting lever is small in proportion as the beam is thinner, a plank bends and breaks more readily than a beam, and a beam resting on its edge bears a greater weight than if resting on its side. Where a single beam cannot be found deep enough to have the strength required in any particular case—as for supporting the roof of a house—several beams are joined together, and in great variety of ways, as is seen in house-rafters, &c., which, although consisting of three or more pieces, may be considered as one very broad beam, with those parts cut out which do not contribute much to the strength. The *arched form* bears transverse pressure so admirably, because, by means of it, the force that would destroy, is made to compress all the atoms or parts at once, and nearly in the same degree. The atoms on the under side of an arch, resting against immovable abutments, must be compressed about as much as those on the upper side, and cannot therefore be torn or overcome separately. The whole substance of the arch therefore, resists, almost like that of a straight pillar under a weight, and is nearly as strong. To be able to adapt the curve to the size of an arch, and to the nature of the material, requires in the architect a perfect acquaintance with measures, &c. An error which has been frequently committed by bridge-builders is, the neglecting to consider sufficiently the effect of the horizontal thrust of the arch on its piers. Each arch is an engine of oblique force, pushing the pier away from it. In some instances, one arch of a bridge falling, has allowed the adjoining piers to be pushed down towards it, by the thrust, no longer balanced, of the arches beyond, and the whole structure has given way at once, like a child's bridge built of cards. It is not known at what time the arch was invented, but it was in comparatively modern times. The hint may have been taken from nature; for there are instances in alpine countries, of natural arches, where rocks have fallen between rocks, and have there been arrested and suspended; or where burrowing water has at last formed a wide passage under masses of rock, which remain balanced, among themselves, as an arch above the stream. Nothing can surpass the strength and beauty of some modern stone bridges—those, for instance, which span the Thames as it passes through London. Iron bridges have been made with arches twice as large as those of stone, the material being more tenacious, and calculated to form a lighter whole. That of three fine arches, between the city of London and Southwark, is a noble specimen; and, compared with the bridges of half a century ago, it appears almost a fairy structure of lightness and grace. The great domes of churches, as those of St. Peter's in Rome and St. Paul's in London, have strength on the same principle as simple arches. They are, in general, strongly bound at the bottom with chains and iron bars, to counteract the horizontal thrust of the superstructure. The Gothic arch is a pointed arch, and is calculated to bear the chief weight on its summit or key-stone. Its use, therefore, is not properly to span rivers as a bridge, but to enter into the composition of varied pieces of architecture. With what effect it does this, is seen in the truly sublime Gothic structures which adorn so many parts of Europe. The following are instances, in smaller bodies, of strength obtained by the arched form:—A thin watchglass bears a very hard push; a dished or arched wheel for a carriage is many times stronger to resist all kinds of shocks than a perfectly flat wheel; a full cask may fall with impunity, where a strong square box would be dashed to pieces; a very thin globular flask or glass, corked and sent down many fathoms into the sea, will resist the pressure of water around it, where a square bottle, with sides of almost any thickness, would be crushed to pieces. We have an illustration, from the animal frame, of the arched form giving strength, in the cranium or skull, and particularly in the skull of man, which is the largest in proportion to its thickness: the brain required the most perfect security, and by the arched form of the skull, this has been obtained with little weight. The common egg-shell is another example of the same class: what hard blows of the spoon or knife are often required to penetrate this wonderful defence provided for the dormant life! The weakness of a similar substance, which has not the arched form, is seen in a scale from a piece of freestone, which so readily crumbles between the fingers. To determine, for particular cases the best forms of beams and joists, and of arches, domes, &c., is the business of strict calculation, and belongs, therefore, to mathematics, or the science of measures. It was a beautiful problem of this kind, which Mr. Smeaton solved so perfectly in the construction of the far-famed Eddystone light-house.

FRESCO PAINTING,

Is a term of art, applied by the Italian artists to pictures executed in distemper or size colors. On the revival of the arts in Europe, it became customary to decorate the outsides of churches, palaces, cloisters, and convents, with historical pictures; and, as these were exposed to the impressions of the atmosphere, the term *al fresco* was applied to the species of painting itself. The decorations and scenery in our modern theatres are likewise executed in distemper, or fresco, but there are certain peculiarities attending the Italian method, which we shall attempt to describe. The size of the wall to be decorated being ascertained by accurate measurement, a finished drawing on paper, called a cartoon, was first made, to serve as a model. The artist, then, had a certain portion of the wall covered over with a fine sort of stucco, or Roman cement, of the thickness of an inch, or more, and upon this portion he traced off from his cartoon enough to fill the space. But, as it was necessary to the success and permanency of his work that the colors should be applied while the stucco was yet damp, no more cement was applied at one time than what the artist could finish with convenience in one day. The first part of his operation, after the tracing, was to lay in the masses of color with a large brush, and then to finish up the parts by delicately hatching them over with a series of minute strokes, by means of smaller brushes.

In old writers on fresco painting, different processes are described for mixing up and preparing the colors; but they all agree in stating that the colors should all be native earths or minerals, as lakes and vegetable colors will not stand, and that the whites made use of should be of white chalk, or powdered marble. Secondly, that the vehicle should be a solution of animal glue, prepared by boiling the skins of animals or fishes, such as parings of parchment, glove leather, &c., or from the whites of eggs. One old author, indeed, directs that a certain number of fresh eggs, yolks, shells, &c., should be well beaten up, and pounded in a marble mortar, and that a small portion of good vinegar (say a gill to six eggs) should be added, and the whole mixture beat up with a bunch of fresh twigs cut from a fig-tree. In this way, the white and yolks of the eggs form a sort of emulsion, and, the vinegar dissolving the earthy matter of the shells, renders the vehicle more binding; the yellowness of the eggs would not materially alter the colors, neither would the whites be tarnished thereby, being of chalk, which would not be the case if white lead or ceruse were employed. As to the fig leaves, it is well known that the juice given out by them is a species of Indian-rubber, or caoutchouc—an elastic gum, which will render the colors less liable to crack. In this manner all the finest fresco paintings of the churches in Italy have been executed. The Sistine chapel, Vatican, Grotto Ferrato, Farnesine palace, &c.

It is pretended, that there are specimens of fresco painting extant of the time of Constantine the Great. It began to revive in the sixteenth century. The example of Michael Angelo and Raphael shows how worthy it is of the greatest artist. The painter cannot seduce the senses by soft tints and tender harmony of colors; he is, therefore, reduced to depend solely on form, character, expression. If oil painting is better suited for nice expressions of the slightest emotions of the heart, fresco painting is the field which the true poet-painter will prefer. What can be more sublime than the last judgment of Michael Angelo, in the *Capella Sistina!* How rich and vast are Raphael's conceptions in the *stanze* and *loggie!* The Germans possess at present the most distinguished fresco painters; and Cornelius has established his fame by his grand fresco pictures in the *Glyptotheca*, in Munich. Schnorr is also distinguished in this line; and the *villa Massimi*, near Rome, is a fine monument of contemporary German art, as Overbeck, Schnorr, and Feith painted the three rooms in fresco. Fresco painting was long disregarded, when all noble and grand conceptions seemed to have fled from the art; and it is only in recent times that it has been taken up again, chiefly by the Germans.

MANUFACTURE OF COKE.

On the first introduction of coke, the coals were merely piled on a heap, ignited, and, when sufficiently burnt, the heat was smothered by covering the pile with dust and sand. Since the matter has been better understood by practice, and a knowledge of chemistry, more perfect and economical methods have been adopted: these consist generally in the use of close furnaces or ovens, mostly contiguous to the iron works, and under the same management. Parkes has described the hemispherical ovens for the burning of coke, which exist in the neighbourhood of Sheffield; they are about ten feet wide at the base, and two feet at the aperture: the wall of brick eighteen inches in thickness.

"When these ovens are once heated, the work goes on night and day without interruption, and without any further expense of fuel. It is conducted thus:—small refuse coal is thrown in at the circular opening at the top, sufficient to fill the oven up to the springing of the arch; it is then levelled with an iron rake, and the doorway on the side built up with loose bricks. The heat acquired by the oven in the former operation is always sufficient of itself to light up the new charge, the combustion of which is accelerated by the atmospheric air that rushes in through the joints of the loose bricks in the doorway. In two or three hours the combustion gets to such a height, that they find it necessary to check the influx of the air; the doorway is therefore now plastered up with a mixture of wet soil and sand, except the top row of bricks, which is left unplastered all night. Next morning, when the charge has been in twenty-four hours, this is completely closed also; but the chimney remains open till the flame is gone, which is generally quite off in twelve hours more; a few loose stones are then laid over the aperture, and closely covered up with a thick bed of sand or earth. All connection with the atmosphere is now cut off, and in this situation the whole remains for twelve hours to complete the operation. The doorway is then opened, and the cokes are raked into iron wheelbarrows to be carted away. The whole operation takes up forty-eight hours, and as soon as the cokes are removed, the ovens are again filled with coal for another burning. About two tons of coals are put in for each charge, and the cokes produced are ponderous, [illegible]emely hard, of a light grey color, and shine with metallic lustre.

"When coke is required to be more of the nature of charcoal, the process is conducted in a different manner. The small coal is thrown into a large receptacle, similar to a baker's oven, previously brought to a red heat. Here the door is constantly open, and the heat of the oven is sufficient to dissipate all the bitumen of the coals, the disengagement of which is promoted by frequently stirring with a long iron rake. The coke from these ovens, though made with the same kind of coal, is very different from that produced by the former operation; this being intensely black, very porous, and as light as pumice stone." Both these descriptions of coke enter into the process of smelting; the former is capable, not only of acquiring an intense heat, and lasting a considerable time, but likewise of sustaining a great weight of ore in the furnace without presently falling to ashes; the latter sort is more inflammable, but considerably less durable.

MEDICAL RECEIPTS, &c.

Talc Water.—The ancients bestowed high encomiums on a water, or oil of talc, as a cosmetic. We know not in what manner they composed this precious cosmetic, but the following imitations have been given. Take any quantity of talc, divide it into laminæ, and calcine it with sulphur. Then pound it, and wash it in a quantity of warm water. Gently pour off the water, and leave the residue at the bottom of the vessel dry. When dry, calcine it in a furnace for two hours with a strong fire. Take a pound of this calcined talc, and reduce it to a powder, with two ounces of hydrochlorate of ammonia; put the whole in a glass bottle, and set it in a damp place. All the talc will spontaneously dissolve, and then pour off the liquor gently, taking great care not to disturb it. The liquor is as clear and as bright as a pearl.

Oil of Talc.—Take 1 part of Venetian talc and two parts of calcined borax, perfectly pulverize and mix these substances, put them into a crucible, cover it and place it in a furnace. Expose it for an hour to a very violent heat, and at the end of that time the mixture will become a glass of a greenish yellow color. Reduce this to powder, then mix it with two parts of carbonate of potash, and again melt the whole in a crucible. Place the mass thus obtained in a cellar, upon an inclined piece of glass, with a vessel underneath it, and in a short time the whole will be converted into a liquid, in which the talc will be perfectly dissolved.

Tar Water.—A remedy celebrated by Bishop Berkeley, is prepared by infusing tar with boiling water, which produces a yellow empyreumatic liquid.

Taylor's Red Bottle.—British brandy, tinged with cochineal and flavored with oil of origanum.

Taylor's Remedy for Deafness is an infusion of garlic in oil of almonds, colored with alkanet root.

Taylor's Defensor.—Thin isinglass jelly with a little permanent white well mixed in while cooling.

Terro-Metallicum.—An amalgam of tinfoil and quicksilver for filling decayed teeth.

Turlington's Balsam is made with 3 ounces each of aloës, myrrh, balsam of Tolu, balsam of Peru, and olibanum. 9 ounces each of benzoin, and of storax, 4½ pints of alcohol. Digest in a warm place, and add 3 ounces of gum arabic in 1½ pint of water.

Velno's Vegetable Syrup, according to Adair, is composed of a solution of bichloride of mercury triturated with honey and mucilage. According to Swediaur it contains volatile alkali. According to Sir C. Brodie, it is similar to the following:—Take 2 ounces of burdock root, (young and fresh,) sliced, 1 ounce of dandelion root, 1 ounce of fresh spearmint, 1½ dram each of senna leaves, coriander seeds bruised, and fresh liquorice root, and 1½ pint of water; boil down to 1 pint, strain, and when cold add 1 pound of refined sugar, boil to a syrup, and add a small portion of the solution of bichloride of mercury.

Walker's Jesuit's Drops.—Take 1 pound of gum guaiac, 3 drams of balsam of Peru, 2½ pints of rectified spirit; make into a tincture. Dose 1 dram to 2 drams as an anti-venereal. It is the same as the balsam of guaiac, and the anti-venereal elixir.

Want's Powder, for gout and rheumatism, is the powdered bulb of colchicum, with some other powders, to disguise it. Mr. Want was the first modern surgeon who discovered the influence of colchicum on gout, though it was known to the ancients.

Ward's Sweating Powders.—A combination of opium and white hellebore-root.

Ward's White Drops.—A solution of bichloride of mercury with carbonate of ammonia; or a nitrate of mercury, prepared by dissolving mercury in nitric acid, and adding solution of carbonate of ammonia.

Ware's Golden Ointment.—Take 1 ounce of fresh butter, free from salt, 1 dram of the powder of nitrated oxide of mercury; make an ointment for ophthalmia and ulcers.

Warner's Cordial.—Take 1 ounce of bruised rhubarb, ½ ounce of senna, 1 dram of saffron, 4 drams of powdered liquorice, 1 pound of pounded raisins, and 3 pints of brandy; digest for fourteen days, and filter.

We[illegible]er's Diet Drink, or *Cerevisia Anglicana.*—A decoction of liquorice, guaiac, sarsaparilla, sassafras, turmeric, bitter-sweet, betony, and thyme, boiled, with or without sugar, to the consistence of syrup.

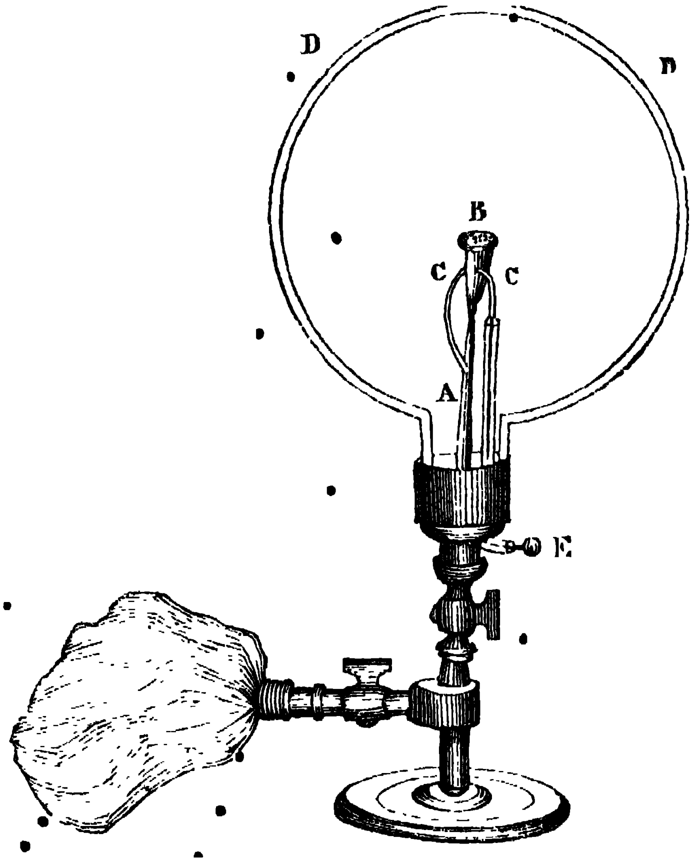
Westphalian Essence of Wood Smoke.—Macerate together for several weeks, ½ dram of Barbadoes tar, 1 dram of liquid burnt sugar, 5 drams each of port wine and vinegar, 2 drams of common salt, and 6 ounces of water. Used for curing hams.

Whitehead's Essence of Mustard does not contain, according to Dr. Paris, a particle of mustard, but is merely balsam of Tolu with resin. According to Mr. Brande, it is composed of camphor, oil of turpentine, and spirit of rosemary, mixed with mustard flour.

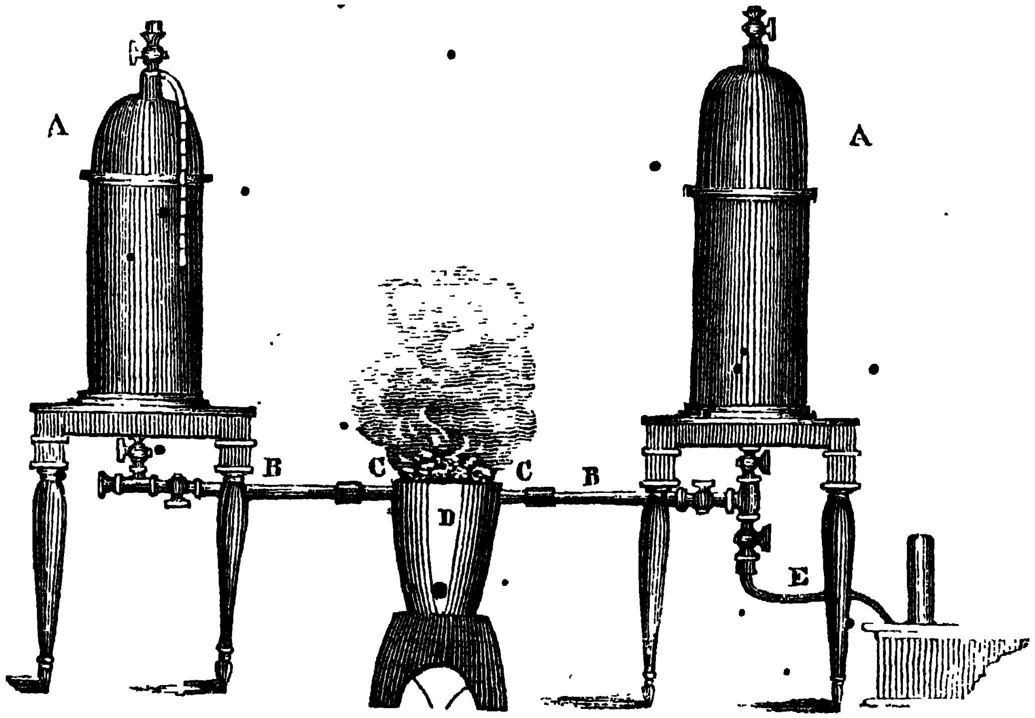
Wodroof.—A native plant, common in woods, which has a fine odour of hay when dried, but when green is nearly inodorous. It is said to be deobstruent. The flowers give a fine flavor to tea and wines.

Zanthoxylon Fraxineum.—Prickly Ash. The bark is stimulant and sialagogue, and is used in rheumatic tooth-ache, and chronic rheumatism, in doses of 10 grains to 1 scruple of the powder; or 4 ounces to 8 ounces of the decoction every four hours.

Zingeber.—Preserved Ginger Root. This is brought from the East Indies, and is almost transparent. That which is candied at home is opaque. It is a good stimulant for the gouty and nervous.



COMBUSTION OF THE DIAMOND.



COMBUSTION OF THE DIAMOND.

The combustibility of the diamond seems first to have occurred to Newton. In the year 1694, the Florentine Academicians verified his anticipations, and proved its destructibility by heat by means of a burning lens. The *products* of its combustion were first examined by Lavoisier in 1772, and subsequently with more precision by Guyton Morveau, in 1785. In 1797, Mr. Tennant demonstrated the important fact, that when equal weights of diamond and pure charcoal were submitted to the action of, red-hot nitre, the results were in both cases the same: and in 1807, the combustion of the diamond in pure oxygen was found by Messrs. Allan and Pepys to be attended with precisely the same results as the combustion of pure charcoal.

When the diamond is heated in the flame of the blow-pipe it soon begins to burn, and the combustion continues as long as the temperature is sufficiently high, but it does not produce heat enough, during its combination with the oxygen of the atmosphere, to maintain its combustion. If, whilst thus burning, it be introduced into a jar of pure oxygen, the combustion continues longer, and sometimes till the whole is consumed: the best support for it, in this experiment, is a small loop of platinum wire, or a very small and thin platinum spoon, perforated with many holes; in this it may first be intensely heated by the oxygen blow-pipe, and whilst burning carefully immersed into a bottle of pure oxygen gas, containing a little lime-water: a good cork, through which the wire of the spoon passes, should secure the mouth of the bottle: it will thus go on burning brilliantly for some time, and the formation of carbonic acid be shown by the milkiness of the lime-water.

The combustion of the diamond may be more perfectly effected by placing it upon a platinum capsule in a jar of pure oxygen inverted over mercury, and throwing upon it the focus of a burning lens. Sir H. Davy, when at Florence, in 1814, used for this purpose the same lens which was employed in the first trials on the action of solar heat on the diamond, instituted by Cosmo III., Grand Duke of Tuscany: he found that the diamond continued to burn in the oxygen, after being withdrawn from the focus, with so brilliant a light as to be visible in the brightest sunshine, and with very intense heat.

The Fig., No. 1., is another form of apparatus which may be conveniently employed for exhibiting the results of the combustion of the diamond. It consists of a glass globe D D, of the capacity of about 140 cubical inches, furnished with a cap, having a large aperture; the stop-cock, which screws into this cap, has a jet A rising from it, nearly into the centre of the globe; this is destined to convey a small stream of hydrogen, or other inflammable gas. Two wires C C, terminate at a very little distance from each other, just above this jet, and are intended to inflame the stream of hydrogen by electrical sparks; one of them commences from the side of the jet, the other is inclosed and insulated nearly in its whole length in a glass tube: the tube and wire pass through the upper part of the stop-cock, and the wire terminates on the outside in a ball or ring E, at which sparks are to be taken from the machine, either directly or by a chain. On the end of the jet is fixed, by a little socket, a small capsule B, made of platinum-foil. This capsule is pierced full of small holes, and serves as a grate to hold the diamonds. Its distance is about three quarters of an inch from the end of the jet; and the arm, by which it is supported, is bent round, so that the stream of hydrogen shall not play against it. The stop-cock screws by its lower termination, on to a small pillar, fixed on a stand, and at the side of this pillar is an aperture, by which a bladder filled with gas may be connected with the apparatus.

On using the apparatus, the diamond is to be placed in the capsule; and then the globe being screwed on to the stop-cock, the latter is to be removed from the pillar and placed on the air-pump; the globe is then to be exhausted, and afterwards filled with pure oxygen; or, lest the stream of oxygen in entering should blow away the diamond, the globe may be filled with the gas first, and then, dexterously taking out the stop-cock for a short time, the diamonds may be introduced, and the stop-cock replaced. The apparatus is then to be fixed on the pillar, and a bladder of hydrogen gas attached to the aperture. Now, passing a current of sparks between the wires, a small stream of hydrogen is to be thrown in, which inflaming, immediately heats the capsule and diamonds white-hot; the diamonds will then enter into combustion, and the hydrogen may be immediately turned off and the bladder detached. The diamonds will continue to burn, producing a strong white heat, until so far reduced in size as to be cooled too low by the platinum with which they lie in contact. When the flame of hydrogen is used to heat the diamonds, it is evident a little water will be formed in the globe, but this is of no consequence except in attempts to detect hydrogen in the diamond; the inconvenience may be obviated, if required, by using the flame of carbonic oxide. As, however, no hydrogen has at any time been detected in the diamond, it is better to use that gas as the heating agent; for then the carbonic acid, produced by the combustion, is unmixed with that from any other source, and may be collected, and its quantity ascertained.

Fig. 2 is the method of illustrating the products of the combustion of the diamond, as employed by Messrs. Allen and Pepys: A A are mercurial gasometers, one of which is filled with pure oxygen gas. The brass tubes B B, properly supplied with stop-cocks, issue from the gasometers, and are connected with the platinum tube C C, which passes through the small furnace D. E is a glass tube passing into the mercurio-pneumatic apparatus, by which the gas may be drawn out of the gasometers into convenient receivers. A given weight of diamond is introduced into the centre of the platinum tube, which is then heated to bright redness, and the gas passed over it, backwards and forwards, by alternately compressing the gasometers. Carbonic acid is soon formed, and it will be found that the increase of weight sustained by the oxygen is equivalent to that lost by the diamond; that the oxygen undergoes no change of bulk; and that the results are, in all respects, similar to those obtained by a similar combustion of perfectly pure charcoal.

SUSCEPTIBILITY OF VEGETABLES.

Of the susceptibilities of living fabrics, some are common both to plants and animals, others are proper to animals only. 1st. Tissual susceptibility; that is, the physical capacity of extension and of spontaneous contraction which is found to be inherent in primary tissues, is common to both. Thus, in elevating the arm to a perpendicular position, the tissue of the arm-pit is extended to more than double its former length; and in the forcible bending of the bough of a tree there is an extension of a similar sort. 2nd. Vital susceptibility, or that capacity of living organs which enables them to receive and to obey the impulse of *stimuli*, of the impression and operation of which the individual knows nothing, is common to both also. Thus the fluids that are lodged in the soil excite the susceptibilities of the extreme fibrils or spongiolæ of the root, being first admitted into, and then propelled and distributed throughout the fabric, while the individual knows nothing of it. Thus, also, the stomach of animals is excited to action by the presence of aliment, and the heart by the ingress of blood; and thus are digestion, circulation, and nutrition maintained in the fabric without either our knowledge or our notice. But, 3rd. Cerebral susceptibility, or that capacity of living organs which enables them to receive and to obey the impulse of stimuli, and to transmit the impression made to a common centre of feeling and of consciousness, is proper to animals only. Yet it has been claimed for plants also; and the claim has been advanced by botanists of the highest celebrity, as well as by physiological inquirers of no mean reputation. Dr. Watson, bishop of Llandaff; Dr. Darwin, the author of the "Loves of Plants;" Dr. Percival, of Manchester; and Sir J. E. Smith, the founder and late President of the Linnæan Society of London—have each of them been advocates for the doctrine of vegetable sensation. Now, a doctrine supported by writers of such eminence and distinction must surely have something in it, if not very convincing, at least very plausible. Let us see on what foundation the doctrine is made to rest.

One of the several arguments adduced in defence of the doctrine is that of the fact of the excitability of plants by the natural *stimuli* of light and heat; and, as it is also alleged, of cold and of darkness. 1st. If a plant is vegetating in a dark chamber, it will turn itself into any hole or aperture that may be opened for the admission of light. 2nd. Leaves, if not prevented by some insurmountable and accidental cause, do uniformly turn their upper surface to the light. 3rd. The leaves of many plants assume a position in the night very different from that which they occupied in the day. This phenomenon Linnæus denominated the *sleep of plants*. 4th. The flowers of many plants open and shut only at certain hours or periods of the day. This, Linnæus denominated the *Horologium Floræ*.—5th. Many plants protrude their leaves only when the temperature of the atmosphere has reached a certain point of elevation; some in January, some in February, and some in March. This, Linnæus denominated the *Calendarium Floræ*.

To account for the above phenomena, Darwin claims for vegetables the faculty of sensation, and gratuitously assigns to them a *sensorium* or union of nerves residing in each bud. We may fairly contend, however, that the mere susceptibility of the vegetable to the stimulus of light and heat, is no proof of its being endowed with the faculty of sensation; because even in animals, which evidently possess sensation, there are still many movements of which the individual is not conscious. Take the case of the circulation of the blood, or of the processes of digestion, absorption, and nutrition, and you have a good example of the fact. Besides, the action of light and heat would amount to something, even upon bodies destitute both of life and of feeling. Expose a piece of dyed cloth to the action of the direct rays of the sun, and you will soon begin to see its color begin to fade. Hold a sheet of paper or of parchment before a bright fire, and it will immediately roll itself up into a scroll. Place a snow-ball in the same situation, and it will quickly dissolve into water. Try the experiment upon a piece of wet clay, and it will shrink in all its dimensions. Repeat the experiment upon a lump of wax, and it will speedily expand in volume. Hence we regard the bending of the stem towards the small aperture in the dark chamber, and the unfolding of the flower at a given temperature, as being nothing more than the chemical action of light or of heat attracting or expanding the vegetable fabric, and thus facilitating the growth and nutrition of the plant. But vegetables, says Darwin, perceive not only the impression of *stimuli*, they perceive also negatives, and are consequently endowed with sensation. Cold and darkness are negatives. Admitting that cold and darkness are negatives, what do we gain by it after all? If the stimulus of heat or of light is withdrawn, its effect must necessarily subside, whether its withdrawal is perceived by the body that has been stimulated or not. If the paper or parchment is withdrawn from before the fire, and placed in a cooler atmosphere, it gradually recovers its former shape without any perception of the negation of cold. If we do not concede the attribute of sensation to the phenomenon of the excitability of vegetables by the action of the natural *stimuli* of light and of heat, it has been thought that we must concede it to the phenomenon of their irritability by the action of accidental and extraneous or artificial *stimuli*. The shrinking of the leaflets of *Mimoza pudica* when touched; the closing of the leaves of *Dionæa Muscipulas*, and of several species of Drosera if a fly but alights on them; the sudden incurvation of the filaments of *Berberis communis* if touched on the inner side, and the hasty reflection of the style of *Stylidium fruticosum* if the stigma is but touched with the point of the finger, are the examples of vegetable irritability which are usually adduced in support of the doctrine in question.

But still we have no certain or decided proof that plants are endowed with the attribute of sensation. The irritability which they exhibit upon the application of accidental or artificial *stimuli* does not prove the fact. Sir J. E. Smith found that the stamens of the flower of the Barberry retained their contractile power even when the petal with its annexed filament had fallen to the ground, and could no longer be said to be in a living state. But a faculty which plants may retain, even when dead, is surely no proof of their having been endowed with sensation when alive. Besides, they present no apparatus whatever of feeling or of perception—nothing that is analogous to the brain, nothing that is analogous to the nerves of animals. But does not the Mimosa, it may be said, shrink even from the touch? There is a great difference between a mere shrinking from the touch, and a shrinking from danger apprehended, as in the case of animals. The harlequin that is made of goldbeater's skin, shrinks from the touch or heat of the hand, and tumbles about as if it were actually alive; but no one, in spite of its whimsical freaks, supposes that it feels. Might not the phenomenon of the irritability of plants be accounted for from the influence of the electric or galvanic fluid, without having recourse to the faculty of sensation? If a dead frog has been made to leap by means of the agency of this power, and a dead man to shake his fist in the face of the experimenter, well might we ascribe the shrinking of the Mimosa, the collapsing of Dionæa, and the elastic spring of Stylidium, to a similar cause.

Further, the advocates of the doctrine of vegetable sensibility contend that they find in vegetables movements that indicate not only sensation, but also instinct. What less than instinct, it has been said, could direct the radicle in its irresistible descent into the earth, and the plumelet in its irresistible ascent into the air in the process of germination; or the twining stem in its spiral ascent around its prop, never taken at random, but always in a determinate manner; or the tendril to multiply its circumvolutions, till it has got a hold that is inseparable? The fact is, indeed, inexplicable on grounds merely chemical or mechanical, and yet the admission of instinct does not solve the difficulty. Neither do we think the term is rightly applied to express the growth or direction of any organ or fabric. The legitimate use of it seems rather to be confined to the expressing of the act of an individual being regarded as sentient. We might as well say that the upper growth of the teeth of the lower jaw, and the downward growth of the teeth of the upper jaw, and the twisted and spiral growth of the horns of the ram, are the result of an instinct born with, and inherent in, these organs. Thus the idea of the existence of instinct in vegetables is palpably erroneous. The phenomena for which it is alleged to account are the result of vitality, but not of feeling. We regard the term spontaneity as being less exceptionable than that of instinct; but still it is a spontaneity that feeling has nothing to do with.

Lastly, the advocates of the doctrine in question regard certain vegetable movements as affording indubitable indications, not only of sensation and perception, but of volition, desire, and design. 1st. If the roots of vegetables are lodged in the earth, they are found to have the power of protruding their fibres in the direction of the best soil. 2nd. If a vessel filled with water is placed within six or eight inches of the stem of a growing cucumber, the shoot will elongate in the direction of the vessel, and follow it till it reaches the water. 3rd. The movements of the leaves of *Hedysarum gyrans* are perpetual, for they cease neither by night or by day; and hence we are called upon to believe them to be voluntary. 4th. The water lily does not put forth its blossom till it reaches the surface of the stream in which it grows, be it shallow or be it deep. 5th. The style of *Gloriosa superba* bends itself towards the stamens, and the stamens of Saxifraga bend themselves down to the stigma, in obedience, as it has been alleged, to a sort of amorous desire.

(To be continued.)

PHENOMENA OF THE BAROMETER.

THE phenomena of the barometer, considered as a weather-glass, have been very differently stated and explained by various writers; and they are so precarious, that it is extremely difficult to form any fixed and general rules concerning them. Although we have reason to believe, that the barometer never fails to indicate a storm, or any very great change of weather, for some hours before it occurs; yet its variations afford no indications or prognostics that are absolutely certain, with respect to those less considerable changes, to which the weather is subject in our variable climate. With certain restrictions they afford some ground for probable conjecture; and these restrictions are to be determined merely by the sagacity of long-continued observation and experience. Strictly speaking, the height of the mercury in the barometer has no immediate and necessary connection either with rain or fair weather. That its variable height is the immediate consequence of the variable pressure of the atmosphere, is a fact that admits of no doubt; but the causes of this variable pressure have not yet been fully and satisfactorily ascertained; and how far the state of the weather, in all its minute and sudden changes, depends upon it, is a question that is still to be determined. M. Pascal was one of the first persons who particularly observed the variations of the barometer, and referred them to corresponding changes in the weight of the air; but he acknowledges, that it is very difficult to explain both the one and the other, as well as the connection that subsists between them. He observes, in general, that the mercury is commonly highest in winter and lowest in summer; that it is least variable at the solstices, and most variable at the equinoxes: and he adds, in direct contradiction to later experience, that the mercury usually falls in fine weather, and that it rises when the weather becomes cold, or the air is loaded with vapours. M. Pascal was followed by Perrier, Beal, Wallis, Garcin, Garden, Lister, Halley, Gersten, De la Hire, Mariotte, Le Cat, Woodward, Leibnitz, De Mairan, Bernouilli, Muschenbroek, &c.; all of whom have given different solutions of the phenomena of the barometer.

The principal observations that have been made on the variations of this instrument, are summed up by Mr. Kirwan in the following particulars:—

I. The more considerable elevations and depressions of the mercury in the barometer happen at a very short interval of time, in places very remote from each other. This correspondence was observed by Mr. Derham, in 1699, between the heights of the mercury at Upminster in Essex, and Townly in Lancashire; and afterwards by M. Maraldi, between the variations at Paris and Genoa, at the distance of nearly four degrees of latitude, who adds, during these variations different winds prevailed at these places. But Mr. Kirwan observes, that where there is a considerable difference of longitude, the like agreement is not found.

II. The deviations of the mercury from its mean annual altitude are far more frequent and extensive in the neighbourhood of the poles than in that of the equator. At Petersburgh, in 1725, the mercury once stood at the amazing height of 31.59 inches, if we may credit Mr. Consett; and yet it has been so low as 28.14 inches. In the northern parts of France, the variations are greater than in the southern: at Naples, they scarcely exceed one inch. In Peru, under the equator, and at the level of the sea, they amount only to two or three tenths of an inch; but in other parts, within a few degrees of the line, on the approach of the rainy season or of hurricanes, the barometer falls an inch or more.

III. The variations without the tropics are greater and more frequent in the winter, than in the summer months.

IV. The variations are considerably smaller in very elevated situations than on the level of the sea. Thus M. Bouguer observed, that on the coast of Peru the variations extended to ¼ of an inch; at Quito, elevated 9374 feet above the sea, they comprehend only 0.087ths of an inch. Saussure made similar observations in Savoy, as did M. Lambert in Switzerland.

V. The mean height of the barometer on the level of the sea, in most parts of the globe hitherto examined, is about 30 inches: M. Bouguer, under the line, observed it at 29.908 inches; but as his barometer was not purged of air by fire, it stood lower than it should have done. Sir G. Shuckburgh, on a mean of several observations on the coasts of Italy and England, found it at 30.04 inches, when the temperature of the mercury was 55°, and that of the air 62°. The mean height of the barometer in London, upon an average of two observations in every day of the year, kept at the house of the Royal Society, for many years past, is 29.88; the mean temperature or height of the thermometer, according to the same, being 58°. The greatest height observed by Sir G. Shuckburgh, Dec. 26th, 1778, in London, was 30.948 inches, the thermometer being at 47°; and, reduced to the heat of 50°, it was 30.957; and this, he says, is the greatest height which, as far as he has been able to collect, it has ever been known to stand at in any country, where observations have been made and recorded, since the first invention of this instrument. In the proximity of the poles, says Mr. Kirwan, the annual mean heights of the barometer differ much more from the standard than in the more southern parts of our hemisphere.

ENGRAVING.

(Resumed from page 247, and concluded.)

In the last paper upon this subject, we supposed the learner to have proceeded with his work to completion and comparative success, but that some retouches and alterations were requisite; we must anticipate these in order to explain the cause and suggest the remedy. First, then, we will imagine that the ground of the picture is specky where it should be clean. This is called false biting, and arises either from the ground being imperfectly laid on, or that it has been injured during the tracing, and the injuries not afterwards properly covered with the Brunswick black, to preserve the place beneath from the action of the acid. These false bites must be taken off by rubbing them with the burnisher, or if they should be very deep, the scraper may be applied first, and then the burnisher; in either case the plate must be smoothed afterwards with the charcoal and oil, and finally with the oil rubber. Second, suppose the lines on any part of the plate are too dark, so as to look coarse in the fore-ground, or not in sufficient gradation behind; or if they require softening, as for example, around an artificial light, or in the gradation of the sky or a cloud. This want of keeping may arise from the imperfect or too long continued action of the acid, or it may be caused by the very nature of the subject, or it may be said the very nature of the art. It is seldom that any very great nicety is required in mere etchings in gradation of shade, and even when required, the graver is usually employed for touching up; yet without this much may be done by the judicious use of the scraper, burnisher, and charcoal. Thirdly, suppose a greyish tint passes over a part of the picture which should be white; this is a fault which arises from carelessness, and cannot occur to an experienced engraver, though to a beginner it is of frequent occurrence. It arises from acid being accidentally spilled over the surface, and which, although wiped off again, leaves its stain; or it may arise from wiping the plate after it is cleared from the ground with a rag which has been used before for wiping up such acid as may have been spilled on the table, and therefore has imbibed enough to do injury. Marks such as these are often found on the margin of plates, arising from the biting in liquid penetrating beneath the bordering wax. Charcoal used with water or oil will mostly be sufficient to remove stains of the above description. The fourth and greatest fault, and that which is with the most difficulty remedied, is that the whole is faint and wanting in decision and sufficient depth of color. This is the general result of inadequate biting in, and which arises from two causes: one of them is, that the action of the acid has not been sufficiently prolonged; the other, that the bubbles arising have not been brushed off as formed. If the first is the only cause, the etching will appear very uniform and the lines perfect and delicate, and when examined by the microscope will look tolerably clear; but if the latter be the cause, then the lines will look confused, and being examined by the same microscopic test, it will be found that they present the appearance of a series of small holes, not by any means uniform in size, nor contiguous to each other. Let it be remembered, that whenever bubbles of gas arise, they form so many spaces from which the direct action of the acid is excluded, and the acid only acts upon the part of the lines between the bubbles, until these rising, leave the space beneath again open; thus irregularity of action must necessarily take place, and the result is as stated, and it is of that nature as scarcely to admit of a remedy; but when merely bitten in too little, the plate may be darkened by a process called *re-biting*, one however so difficult that many an experienced engraver has completely failed in attempting it. It consists in laying a fresh ground upon the plate, and pouring acid upon it as at first, stopping the operation according to the judgment of the operator. The exact method of re-biting is this:—Warm the plate, but do not make it so hot as at first, but only sufficiently so to melt the ground composition, and contrive to keep it at this heat, either by laying it on hot paper or other substance which is a bad conductor. Rub on the margin of the plate a little of the etching ground, and using a tolerably clean dabber, take up a small portion of the ground from the margin, and dab it gently upon the part to be re-bitten. If this be done very carefully, it will cover the surface of the plate, and yet leave the lines free. To accomplish this, the success of the whole depends. When it is thought that a sufficient ground is thus laid, the plate has become cold, and the bordering wax is made to surround it, a dilute acid is poured on, (it must be much more diluted than in the usual process of first biting.) The plate must now be watched carefully, and if the acid is seen to bite on the general surface, it must be instantly poured off, and a fresh ground laid: on the other hand, if the acid does not bite in the lines, the purpose intended will not be accomplished, and a fresh ground must be laid in this instance as well as in the former, though from a different cause. Another method of re-biting is more easy, but the effect is scarcely so good. Rub a little whiting and water, made to the consistence of treacle, over the plate; then wipe it from the surface, but still leave it in the lines, by exactly the same method as the copper-plate printer inks and cleans his plates in printing. Heat the plate and lay on a general ground. When dry or cold, and bordered with wax, pour the acid over it; this will break up all the lines instantly, and penetrate into them.

In every instance of re-biting, the plate must be very carefully cleaned, so that no ink whatever shall remain in the lines; the best method of doing this is to warm it, and then, while warm, wash it with spirits of turpentine and pearl-ash water, by means of a rag. A white coat of pearl-ash will most likely be left on the plate; to remove this, let the plate be washed with warm water, it will then be fit for the application of the re-biting ground. A fifth fault in an etching is where the lines appear rough and coarse, and the closer of them blended together; this arises from the acid being too strong, and in consequence of having broken away the edges of the ground around the lines, so that they, instead of being deep and sharp, are shallow, wide, and ragged. The sixth and last defect we shall mention, is when certain lines or small detached portions of the plate are pale, or appear as if untouched by the acid. This may arise from several causes; first, from the etching needle not having penetrated through the ground, consequently the acid has not bitten, or perhaps from a little grease having got upon the defective part before biting it, which may also have impeded the action of the acid. Re-biting is a remedy, if the disaster be extensive, or if the lines are not sufficiently deep to admit of this, retracing is the only resource; if the defect is confined to certain small portions or lines, the process of *dry-pointing* may be adopted; this is merely taking a pointed steel wire (a needle is scarcely strong enough), and scratching over the lines of the defective places, observing to clear off the roughnesses thus thrown up on the edges of the lines by the scraper and charcoal.

We have thus minutely described the process of etching, as we have long practised it, and trust that no part of the art has been omitted in the above account; at the same time the tyro must not expect that it is possible to describe any art of so purely a practical nature as this, so as to leave no difficulty for him to surmount, and much must be allowed for experience, tact, and facility of execution, but with ordinary attention, these minor difficulties will be soon removed.

ACTION OF ISINGLASS IN CLEARING MALT LIQUOR.

BY MR. SAMUEL ROBERTS.

In explaining the action of isinglass in clearing malt liquor, two subjects present themselves for particular consideration.

The first is the nature and properties of isinglass. The second is the change which takes place in malt liquor during the process of fermentation.

The best isinglass is obtained from the sounds of the fish of the genus Accipenser, especially from the sturgeon, found in the Danube, and the rivers of Muscovy. It is also obtained from the sounds of the Beluga, and Huso Germanorum.

Isinglass is almost entirely gelatine, 98 parts in every 100 of good isinglass being soluble in boiling water.

The properties of gelatine must therefore be considered, it being analogous to pure isinglass.

Gelatine is distinguished from all animal principles, by its ready solubility in boiling water, and also in most of the diluted acids, which form excellent solvents for it.

Gelatine is perfectly insoluble in alcohol, and almost equally so in cold water. It is precipitated from its solutions by infusions of tannin.

An infusion or tincture of galls, will precipitate it from its solution in 5,000 times its weight of water.

These are briefly the properties of gelatine, or pure isinglass, which should be borne in mind in operating on it.

A great variety of isinglass is offered for sale, at a range of prices from three to sixteen shillings per pound: and the relative value of each kind may be known by the following tests:

'In the first place, isinglass should remain unchanged by being steeped in spirit of wine or alcohol, from 50° to 60° over proof, in which gelatine (the chemical principle of isinglass) is insoluble. The alcohol, or spirit of wine, in which the isinglass has been steeped, should then be tried with a few drops of tincture of galls; if the liquor remain clear and unchanged, it is much in favor of the character of the isinglass. If, on the other hand, the tincture of galls causes a precipitate from the alcoholic liquor, the isinglass is not pure, as it contains something more than pure gelatine.

Different samples of isinglass which have remained unchanged in alcohol or spirit of wine, should also be tried by the two following methods, before an opinion can be given as to their relative value. Try given weights of each sample (one-eighth of an ounce, for instance, in three ounces of water by measure) in separate vessels; bring them gradually to a boil, occasionally stirring each sample. While hot, strain the different solutions through muslin, into separate vessels. In proportion to the quantity of undissolved matter left upon each strainer, may the solubility of the different samples be ascertained; that which leaves the least residuum will form, when cold, the strongest jelly, upon which the clearing property of isinglass depends. The remaining trial to which the different samples are to be submitted, is the last and most decisive one. Equal weights of each sample (the one-fourth of an ounce, for instance,) are to be cut into very small pieces, and each one-fourth of an ounce put into half a pint, of hard or sour beer, and the several vessels containing the different samples put into an apartment, at from 65° to 75° F., and allowed to remain there for three days, stirring each sample very well, once or twice a day.

At the expiration of that time, there will be an evident difference in the strength of each jelly, provided different qualities of isinglass had been submitted to the experiment, and when the thickest jelly has a small quantity of the tincture of galls applied to it, and stirred through it, it will separate the gelatine from the sample of isinglass in the form of a thick jelly. The other samples which afforded a less solid jelly, will give, with tincture of galls, when stirred through it, a smaller quantity of gelatine in the form of thick jelly.

From the strength of the jelly given, by any sample of isinglass steeped in the above proportion of sour beer, (such as brewers use in making clearings,) and submitted to a temperature not exceeding 75° F., may be ascertained the relative value of that sample, as upon the strength of the jelly, and, consequently, the quantity of gelatine contained in any isinglass, depends its value in clearing malt liquor. The best short-staple isinglass is always soluble in boiling water to about 1-50th residue.

In the preparation of brewers' clearings, isinglass, of a good quality, is steeped in acid beer, in an apartment of about 50° F. temperature. After some time, the isinglass is converted into a jelly by the acidity of the hard beer, it being one of the qualities of gelatine to be soluble in dilute acids.

An advantage arises to the brewer, in always making his clearings from sour beer of an uniform strength of acidity, by which means he is protected from any disappointment resulting from the strength of the clearings he uses, provided he was previously aware of the good quality of the isinglass he submitted to the action of the sour beer.

A simple method may be taken to try the acidity of malt liquor, of which a brewer intends to make clearings. Make a standard liquor of one part (by weight) of the bi-carbonate of potash, dissolved in sixteen parts (by measure) of water.

Suppose, for example, that sixteen fluid ounces of the acid porter to be tried, is put into a vessel that will contain about double that quantity.

Carefully measure a given portion of the standard liquor (say four fluid ounces). Add small quantities of this standard liquor to the acid porter, stirring the mixture upon every addition, until the effervescence ceases, or until the mixture is so neutralized by the standard liquor, as not to change the colour of litmus paper when it is dipped in. The mixture may further be tried by turmeric paper, which should be changed to a higher color by the mixture, thereby showing that the alkali of the standard liquor is slightly in excess.—By the quantity of standard liquor required to produce this result, may be known the greater or less degree of acidity of the porter to be used for making clearings.

Sixteen fluid ounces of acid porter, such as is used by one of the largest breweries in Ireland for making clearings, standing 1° Twaddle's hydrometer, 61° F. temperature, required four fluid ounces of standard liquor to neutralize it, which is equal to 1 part bi-carbonate of potash to 64 parts of acid porter.

This appears a good average strength of acidity for porter, when required for making clearings. If acid porter required less standard liquor to neutralize it than the above quantity, it would indicate a weakness of acidity, which would render such porter an imperfect solvent for isinglass.

Acid porter, such as the above trial was made with, acts upon isinglass, at 61° F., but its action is much facilitated by an increase of temperature of 80° or 90° F.

During the fermentation of malt liquor, the saccharine matter of the malt is gradually converted into alcohol, by the agency of yeast and atmospheric air: ultimately the liquor passes from the vinous into the acetous fermentation.

This latter state is prevented by the exclusion of atmospheric air; hence, the necessity of bunging securely malt liquor, when the vinous fermentation is complete, otherwise the liquor will become sour.

It is when unfined porter is put into casks, and the vinous fermentation has, either in part or entirely, ceased, that brewers apply the clearings to the best advantage. The manner in which isinglass acts upon unfined liquor in clearing or fining it, is by two properties of gelatine (the chemical principle of isinglass.) First, its solubility in weak or dilute acids; and, secondly, by being perfectly insoluble in alcohol, and sparingly soluble in cold water.

When clearings, or isinglass, in combination with sour or acid beer, is applied to malt liquor in a state of vinous fermentation, the alcohol of the liquor disengages the gelatine of the isinglass from its solution in the acid porter, and, being thus liberated, it carries with it the impurities of the liquor which were suspended in it.

The following experiments will better illustrate the theory.—

Mix a small quantity of brewers' clearings with cold water. In a short time the greatest part of the isinglass will be separated.

Filter the mixture through paper, and if a few drops of tincture of galls be added to the filtered liquor, a small portion of gelatine will be precipitated.

This shows that the acid of the clearings held a small quantity of the gelatine in solution This is further proved by adding to the filtered solution as above, a few drops of liquor of ammonia, instead of tincture of galls. The liquor of ammonia should be cautiously added in sufficient quantity, to neutralize the acid contained in the clearings, when the gelatine, which was previously held in solution by the acid, is liberated. By this experiment is shown, the solubility of isinglass in acid porter, and nearly its total insolubility in cold water.

Again, dilute a small quantity of clearings with cold water, until its acidity is so far overcome, as not to redden litmus paper, when applied to it. The isinglass of the clearings will be completely separated from the mixture; for, if a few drops of the tincture of galls be added to the filtered solution, it will remain unchanged.

Add hot water, at about 180° F., to another small portion of clearings, until the liquor is so much diluted as not to affect litmus paper when dipped in it, as in the previous experiment. Filter the liquor through paper, when cold. Gelatine will be detected in this solution by adding a few drops of tincture of galls. This shows the solubility of isinglass in hot water

The next experiments will more clearly show the influence of alcohol in separating gelatine from its solution in weak acid, by which its action in clearing porter in a state of vinous fermentation, is explained.

To sixty parts of cold water, add one part of alcohol, and into this mixture put a small quantity of clearings. In a short time the isinglass will be separated from the mixture, and the liquor will be clear and bright. If, however, the liquor be filtered, and a few drops of tincture of galls be added to the filtered solution, a small portion of gelatine will be disengaged. This is caused by the free acid of the sour porter, of which the clearings are made, holding this small portion of gelatine in solution, as it may likewise be separated by adding a few drops of liquor of ammonia, instead of tincture of galls.

Reverse the experiment by using hot water at 180° F., instead of cold, adding the same quantity of alcohol and clearings, as in the former experiment.

After the mixture has been allowed to settle for a few hours, it will be found that there is but a partial separation of the isinglass, and the liquor will not be so clear as in the former trial, the reason of which is, that the hot water dissolves, and retains in solution a portion of the isinglass of the clearings, the remaining part being separated by the alcohol, in which it is insoluble. The effect would be exactly similar upon malt liquor, if clearings were applied to it which had been made with an excess of acid beer. The alcohol of the unfined porter would disengage but a small portion of isinglass from the clearings, the remainder being held in solution by the excess of acid in the porter, the disengaged gelatine carrying with it particles of vegetable matter, which, when suspended in the liquor, rendered it but semi-transparent.

SIZE OF SKY ROCKETS.

We have been so repeatedly asked, particularly during the last month, as to the exact diameter of sky rockets, that we give the following table, trusting it will be sufficient to satisfy all our friends. It is to be remarked, that a *line* is a twelfth part of an inch :—

Weight.	Interior diameter of case.	Length of ditto.
16 oz.	19½ lines	12·2 inches.
12	17	11·3
8	15	10·12
4	12⅓	7·75
2	9⅛	6·2
1	7½	4·9
½	6¼	3·7

MISCELLANEOUS EXPERIMENTS.

Curious Motion produced in Liquids by Heating and Cooling them.—Fill a large phial with water, and put into it a small quantity of powdered amber, having previously added to the water a sufficient quantity of potash, to make a solution of the same specific gravity as amber. Immerse the phial in a glass of hot water; upon which a very singular internal motion will be immediately perceived. A current of the fluid will rise up the sides of the phial, and another descend in the centre of it. Now take the phial out of the hot water, and observe the effects of its cooling. The currents will be reversed: the external one will descend, and the internal one ascend.—The use of the powdered amber is to make the opposite currents into which the water is thrown, visible.

Solution of Soap in Alcohol is employed to ascertain the comparative hardness of waters. With distilled water it may be mixed, without any change ensuing; but, if added to a hard water, it produces a milkiness, more considerable as the water is less pure; and from the degree of this milkiness, an experienced eye will derive a tolerable indication of the quality of the water. This effect is owing to the alkali quitting the oil whenever there is present in a water any substance for which the alkali has a stronger affinity than it has for oil. Thus all uncombined acids, and all salts, except those of alkalies, decompose soap, and occasion that property in waters which is termed hardness.

To show that Hot Water is Lighter than Cold.—Pour gently hot water into a tall glass nearly filled with cold water; it will remain on the surface: but if cold water be poured upon hot water, it will sink to the bottom. This experiment may be rendered more striking by coloring that portion of water which is poured in.

Prepare a strong solution of phosphorus in sulphuric ether, and dip a piece of white silk in the solution; then, when the ether has evaporated, and the phosphorus begins to fume, apply a solution of nitro-muriate of gold, made by dissolving the crystals of that salt in distilled water; the silk will in an instant be covered with a *splendid* coat of *metallic gold.*

Proceed as in the last experiment, and, instead of the solution of gold, apply, with a camel's-hair pencil, a solution of nitrate of silver. Here the silver will instantly be restored to its *metallic brilliancy*, and frequently attended by *spangles* of a beautiful *blue.*

If a bit of white silk be immersed in an ethereal solution of gold, and dried, the application of phosphorized ether will only impart a *brown* color to the silk; but if, as soon as the phosphorus begins to fume, it be placed on the palm of the hand, and breathed on for a considerable time, the *brown* will be succeeded by a *purple tinge*, and the *metallic lustre* of the *gold* will soon begin to appear.

"An aqueous solution of nitro-muriate of gold," says Mrs. Fulhame, "was poured into a china cup containing some phosphorized ether; instantly the gold began to assume its metallic splendour, attended with a variety of colors, as *purple, blue*, and *red*, the beauty of which cannot be described; but which depend on the *different degrees* of the reduction."

With a needle pass a thread through a small bit of phosphorus, previously freed from moisture by immersing it in alcohol. If this be suspended in an aqueous solution of nitro-muriate of gold, in a few minutes the *phosphorus* will become covered with *pure gold.*

If a piece of white *silk* be dipped in an aqueous solution of nitro-muriate of gold, and exposed while wet to sulphurous acid gas, the whole piece will, in a few seconds, be covered with a coat of *reduced gold*, which remains *permanent.*

If a piece of white silk be immersed in an aqueous solution of nitrate of silver, thoroughly dried in the dark, and then exposed to sulphurous acid vapours, it will suffer no change, nor, if it be wetted with alcohol and then replaced in the vapour, will any sign of reduction appear; but if it be wetted with pure water, and then exposed to the vapour, *metallic silver* will immediately be seen on its surface.

Dip a piece of white calico in an aqueous solution of acetate of lead, and then drop a little solution of sulphuret of potass upon it. If this be now placed in the palm of the hand, the *lead* will be observed gradually to revive, and will soon be reduced to its *metallic state.*

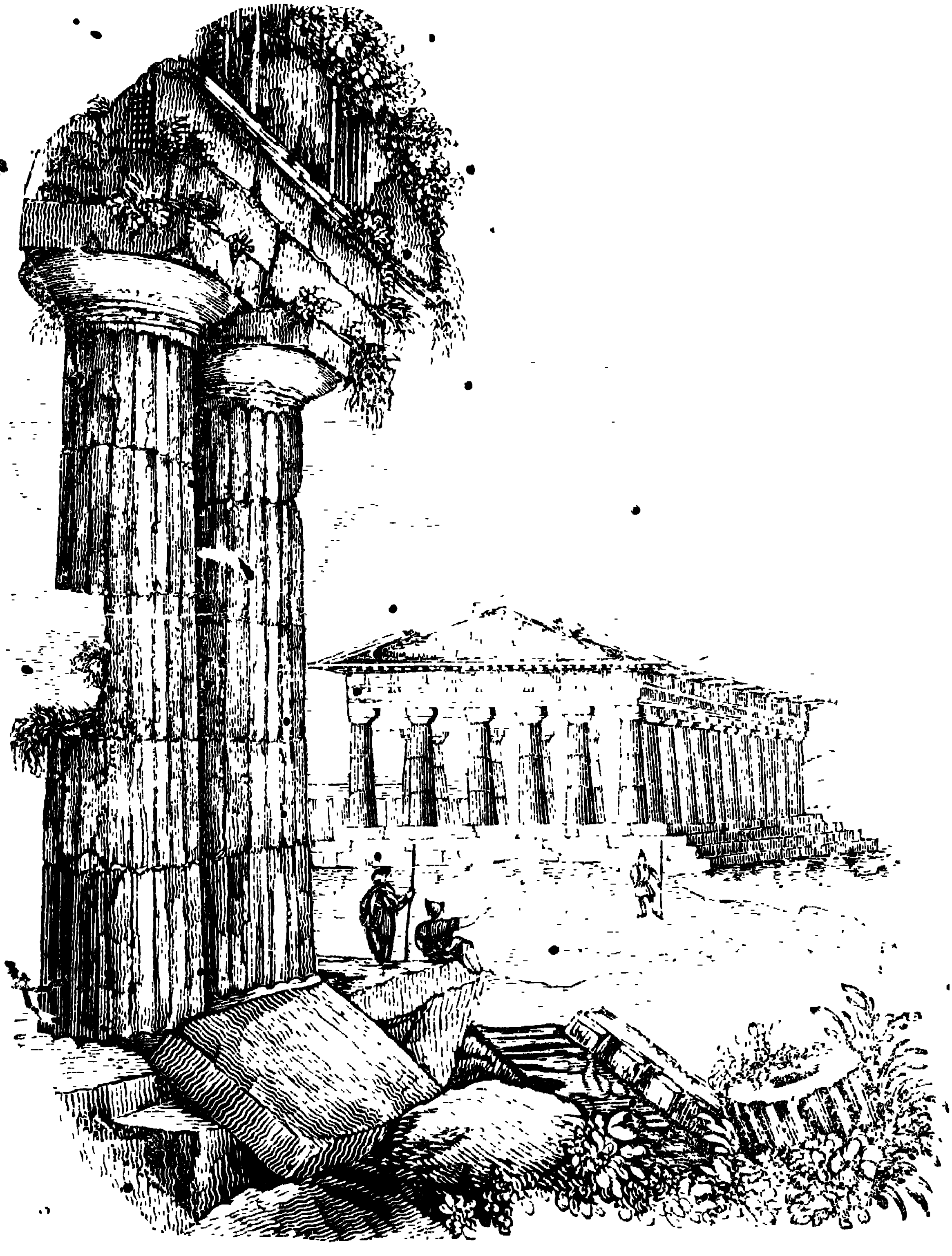
Dissolve some sulphuret of potass in alcohol, and immerse a slip of white silk in the solution. If a drop of an aqueous solution of sulphate of manganese be now applied, films of *metallic manganese*, bright as silver, will instantly appear.

If a bit of silk be immersed in diluted acetate of lead, and exposed while wet to a stream of sulphuretted hydrogen gas, a brown tinge will instantly diffuse itself, like a passing shadow, over the whole surface of the silk, accompanied with a bright coat of *reduced lead*, resembling silver.

If a piece of silk be immersed in an aqueous solution of muriate of tin, and exposed while wet to a stream of the same gas, *reduced tin* of great brightness will immediately cover the surface, and in a little time this will be accompanied by various colors, such as *blue, orange*, and *purple.*

A piece of silk, treated in the same way, but dipped in an aqueous solution of muriate of arsenic, will be covered with resplendent *metallic arsenic*, attended with a *citron yellow color.*

Prepare two glasses of very dilute nitrate of copper; into one drop a little liquid ammonia, and into the other some diluted arseniate of potass. The addition of these two colorless solutions will produce very different effects; for the one glass will have an abundant precipitate of a brilliant *sapphire blue*, and the other a precipitate of a beautiful *grass green.*



THE DORIC ORDER OF ARCHITECTURE.

THE DORIC ORDER OF ARCHITECTURE.

The most ancient Grecian order of architecture was first used in building the temple of Juno, at Argos, at the period when Dorus, father of the Dorians, reigned in the Peloponnesus; though, according to Vitruvius, its symmetry and proportions were not fixed till Ion, the nephew of Dorus, and chief of the Ionians, led an Athenian colony into that part of Asia Minor, which was afterwards distinguished by his name, and there built a temple, after the fashion of those in the Dorian states, the columns of which were six diameters in height, taking the proportion from the ratio that a man's foot bears to the height of his body.

The columns of the Doric order, with their entablature, are imitated from the hovels of the original inhabitants of Greece, consisting of roofs supported by the trunks of trees. The columns were fluted, for the convenience of resting the spears or staves, which the early Greeks always carried with them. The capital consisted of a large convex moulding, in the form of a bow, and a square stone to keep off the rain. The parts resulting from the primitive habitation were carved into mouldings: thus, the architrave represented a wooden beam, and was of a single stone, or block of marble. It was furnished with a projecting band, covering the massive face below. The frieze was an imitation of the ends of the beams; the intervals between them were originally left open, though afterwards they were closed in the form of sunk panels, and the projecting ends of the supposed beams were cut into vertical channels for draining off the rain from the surface: these cut ends always began at the angle of the building, and obtained the name of *triglyphs*, on account of their having two angular channels in the middle, and two half channels at the corners. The channels themselves were called *glyphs*, and were each formed by two planes, meeting internally in a right angle, and each plane externally forming an angle of 135 degrees with the outer surface: the semiglyphs at the extremities, also made an equal angle with the front. Beneath the projecting band of the architrave, and under each triglyph, was a fillet, having six guttæ dropping from it, and corresponding at the ends to the vertical sides of the triglyph. The cornice represented the projecting timbers of the roof, and the under side of the rafters had small conical or cylindrical bodies sculptured on them, in imitation of drops of rain. These were termed *guttæ*, and consisted of three rows under each rafter, each row containing six guttæ. The spaces, or panels between the triglyphs, were called *metopes*, and were generally of a square figure. The ends of the rafters were denominated *mutules*, and were placed one over each triglyph, and one over the centre of each metope. With the exception of the Doric portico at Athens, that of Philip of Macedon, and that of the Temple of Apollo, at Delos, the faces of the triglyphs being the same plane with that of the architrave, or epistylium, the metopes are recessed; but in the instances quoted, they are otherwise. The columns diminish either in a curve or straight line, from the bottom to the top; and, as already observed, are generally fluted: though in the temple of Apollo, just adverted to, and in that at Segesta, they are plain. The flutes are for the most part twenty in number, without fillets, and terminating under the annulets of the echinus of the capital.

Such are the general characteristics of the Grecian Doric, which is almost constantly placed on three or four steps, proportioned to the magnitude of the edifice, and not to the human step.

The remains of this ancient order are to be found in Greece, the place of its invention, and in the Grecian colonies; in Sicily, and at Pæstum, in Italy; to which may be added a few fragments in Ionia. These antique examples are of a sufficiently uniform character to denote its peculiar style or species. The Egyptian buildings, and those of other nations, of a date prior to those of Greece, having entablatures supported by columns, bear much resemblance to an order; but as they have no specific form, and differ in other respects from all the Grecian orders, they cannot prevent us from attributing to the Greeks the invention of a style of building which is to be found nowhere but in their own edifices.

We have already mentioned the temple of Apollo, in the island of Delos, and the temple at Segesta: in the former, the shaft of the column is not fluted, except at the neck, and a small portion of the lower end. In the latter, the shafts are not fluted, and the necking is formed by making it recede within the surface of the upper part; a recess is also to be observed in the lower end of the shaft; but both these receding annular surfaces are smooth, and not sculptured into flutes, as in the former example.

In the portico of King Philip, in the island of Delos, a straight moulding occupies the place of the echinus, and is nothing more than an inverted conic frustum. The proportions are very light, and might be appropriately adopted in private buildings, or works of gaiety.

The largest example of the Doric order, extant, is in the temple of Jupiter, at Selinus, where the height of the column is 48 feet 7 inches: and the lower diameter 10 feet $7\frac{5}{10}$ inches; unlike every other specimen of this order, the flutes are separated by fillets, as in the Ionic and Corinthian orders.

In the temple at Corinth, the shafts are diminished in a convex curve, from the foot upwards, to its termination under the annulets. These columns have the fewest diameters in height, whence it is supposed to be one of the most ancient examples of this order.

The inferior peristyle of the Hypæthral temple at Pæstum, presents a double range of columns, one above the other; in which the lower diameters of the upper tier are not equal to the superior diameters of the columns of the inferior row; but, the sides of both ranges being continued in straight lines, they may be considered as parts of the same cone, with the omission of the intermediate frustum, which is occupied by the podium. The shafts have only sixteen flutes. In the exterior peristyle, the shafts are low, and have a bold projecting echinus; whence, if we may form a judgment of the antiquity of this order by the proportions of the columns, we may rank this example next to that of the temple of Corinth.

The temple of Minerva, at Syracuse, is remarkable in having the columns placed upon plinths all round the exterior peristyle, while those within the pronaos, which are likewise on plinths, have mouldings above, forming what has been called *the Doric base*, with all the specific members, though not of the usual proportions. The capitals have an astragal and fillet under the echinus, instead of annulets, as in all other Grecian examples placed in this situation; in which latter respect, it bears a strong affinity to some of the Italian examples subsequent to the restoration of the Roman style.

In the pseudodipteral temple at Pæstum, the necking of the capital is recessed, as in some of the examples above; and, contrary to the distinctive simplicity of the Doric order, has a row of leaves round it, bending their tops downwards under the annulets. The latter deviation is also to be observed in the hexastyle temple at Pæstum.

The temple of Theseus, at Athens, now St. George's church, the most perfect of the sacred edifices of that place, is a very elegant light example, and calculated for decorating private dwellings.

The Doric portico at Athens, is another very beautiful light example, and applicable to the same uses. This, and the temple of Minerva, are the only Grecian examples in which the crowning echinus is entire.

The Doric of the theatre of Marcellus, at Rome, the only remaining example of the Roman taste, in this order, is quite out of character; for it wants the mutules, which are a peculiar feature of the ordonnance, and their place is occupied by dentils, the distinguishing marks of the Ionic. The middle of the triglyph is in a plane passing through the axis of the column, at right angles to the face of the epistylium. The shaft is too slender, and rather represents a wooden post, than a column of marble or stone. The capital, also, is overcharged with ornaments, and the whole is destitute of the elegant simplicity of the true Grecian Doric.

In the hexastyle temple at Pæstum, the entablature, which appears to be altogether Roman, is without mutules, the soffit of the corona is coffered, and the capital has a row of leaves under the annulets; but the columns bear a nearer affinity to the Grecian than the Roman style.

Previous to the Macedonian conquest, the Doric was the only order known in Greece or its colonies; and though the remaining examples are of various proportions, yet those of the members of the entablature are so very uniform, with respect to each other, that we may venture to lay down the following as the general result; for public buildings, the columns may be five diameters, or five diameters and a half in height, and for private dwellings, six: the diminution may be one-fourth of the inferior diameter. The height of the capital may be two-fifths of the lower diameter, and may be divided into two equal parts, one of which may be given to the abacus, the other to the echinus and annulets; the latter may be subdivided into five equal parts, and four of them taken for the echinus, and the remaining one for the annulets. The height of the entablature may also be divided into four equal parts, of which one may be given to the cornice; and the other three being subdivided into two parts, one part may be given to the epistylium, and one to the frieze, or zophorus. In the Roman Doric the columns may be eight diameters, and set on a square plinth. The abacus, also, may be ornamented with a small ogee and fillet on the upper edge. The intercolumniations of the Doric order are determined by the number of triglyphs which intervene, instead of the number of diameters of the columns, as in the other orders.

To exemplify this order, we have chosen that beautiful specimen, the temple of Neptune, one of the three temples still remaining at Pæstum, while the nearer scene is part of the remains of the celebrated Parthenon, at Athens; so much of the frieze, and so many of the metopes of which are now in the British Museum. The cut gives a good idea of the ancient temples belonging to this order.

SUSCEPTIBILITY OF VEGETABLES.

(Resumed from page 276, and concluded.)

Such are the indications which are thought to demonstrate the existence of vegetable volition, desire, and design. Yet the direction of the root proves only the agency of a sort of physical or chemical attraction between its extreme fibrils and the soil; and the direction of the stem proves only the agency of a similar attraction between the young and tender shoot and the water, like the attraction of the magnet for iron, or of a rubbed cylinder of glass for a tuft of thistle down. At the best it is but a vegetable locomotion. The shoot does not walk towards the water, it only grows towards it. The phenomenon of the self-moving leaves of *Hedysarum gyrans* participates more of the character of animal spontaneity than any other movement hitherto observed in vegetables; and yet it is but a solitary fact, and cannot establish a position that must rest on a copious induction of particulars. How is it that its movements never intermit? In this they resemble rather those movements of the animal system that are wholly involuntary, for such have no intermissions; whereas the movements that proceed from volition soon begin to induce fatigue, and have frequent intermissions. If we were to grant that the water-lily grows by volition, we should be granting too much: for even man, who stands at the head of the animal creation, cannot grow by volition, and cannot add an inch to his stature. The sympathy subsisting between the stamens and pistils is very singular, and very surprising; but the amorous desire which it has been thought to indicate, and the consequent movement which it has been thought to cause, are merely the work of a glowing imagination. It was a fancy entertained by some of the earlier of the Greek philosophers, as we learn from Aristotle, Περὶ φυτων, and it has been sung most delightfully among moderns, by Dr. Darwin, in his "Loves of Plants." The reader is overwhelmed with the beauties of diction, with the harmony of numbers, and with the novelty and apparent plausibility of the doctrine, and is almost persuaded to become a Darwinián; though the doctrine is any thing but a legitimate deduction from the phenomena of vegetable life. It is a very pretty poetical fiction, but a very unfounded philosophical fact. Let us regard the phenomenon as inexplicable, rather than admit a solution that is unwarranted and unwarrantable.

Some have thought that we ought to ascribe sensation to vegetables from the similarity of their structure to that of animals. What though Darwin has called certain vegetable organs veins, others nerves, and others arteries? Their functions are in no respect similar to the veins, nerves, and arteries, of the animal system. You cannot prove the existence of a real circulation; you cannot point out the propelling organ. Where is the heart, where is the stomach, where are the intestines? Where is the proof that nerves reside in the bud, and where are the muscles which they put in action? Even the analogy of leaves to lungs is very faint, but it is better founded than that of veins and arteries; and hence leaves have been regarded from time immemorial as being the veritable lungs of plants.

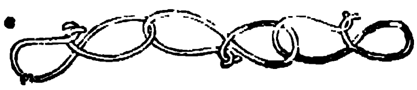
Finally, some physiologists, among whom we may place Sir J. E. Smith, have believed that a legitimate argument for the sensation of vegetables might be drawn from the fact of the benevolence of the Deity, regarding the endowment as having been conferred for the purpose of extending the blessing of conscious existence to an additional and incalculably numerous class of individual beings, which are rendered peculiarly interesting to man, both from their beauty and utility. But as vegetables are exposed indiscriminately to the perpetual attacks both of men and of animals, without having any effectual means whether of defence or escape, sensation could hardly be regarded as a benefit to them, if they were even endowed with it. It would rather be the means of affecting them with pain. They are cut, and cropped, and mangled, and mowed down, and still they are obliged to live and to suffer. If you say that animals suffer also, and that God is yet good, —we answer that the cases are not altogether the same. The lowest animal that exists has always some means or other of defence against, or escape from, the attacks of other animals, or of man. The animal, consequently, has a chance for the preservation of its life, which the plant has not. If you say that the strongest still prevails, or that man, who is placed at the head of the animal creation, does not scruple to slaughter such as are good for food, or to destroy such as have the means of annoying him,—we acknowledge it to be a law of nature that one species of animal shall live at the expense, or by the destruction, of another. Man is even the destroyer of man; yet it is not often by a destruction that is piecemeal. It is not by the cutting off of one slice to-day, and another slice to-morrow, from the hip of the devoted victim, as the savage Abyssinians are said to do to their cattle,—a cruelty which the inferior animals, and even civilized man, inflict most unmercifully upon vegetables —if it be true that vegetables feel—in the many mowings of the green lawn, in the perpetual bite or browsing of the tender herbage, in the pruning and nailing of the annual shoot, and in the periodical clippings or loppings of shrubs or of trees. It is rather by a destruction that is prompt and sudden that man assails his victim, extinguishing life and causing death in an instant; and it is certain that an animal can suffer death but once, though a plant, upon this supposition, might have many deaths to suffer. As it is, we have a sort of instinctive apprehension that plants do not feel, and hence we cut and chop them up without mercy. Hence also the mower whets his scythe, and the reaper his sickle, and the woodman his axe, without experiencing any emotions whether of sympathy or of sorrow; and hence we can bear to witness or to contemplate the havoc that is annually committed in the meadow or in the corn-field, or in the wood or forest, without having our feelings outraged or our sympathies excited; though we cannot bear either to witness or to contemplate the pains and sorrows of suffering animals, but with the tear of sympathy or the cry of commiseration.

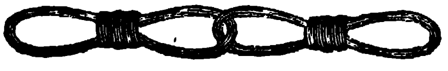
From the above premises it follows irresistibly, that plants, though exhibiting indubitable indications of such tissual and organic susceptibilities as are proper to their rank in the scale of being, do not, after all, exhibit any satisfactory indications of the sensible or voluntary susceptibilities of animals, and do not, in fact, either feel, or will, or desire, or design. The movements which they display are singular, indeed, and surprising, but they are not such as evince any legitimate evidence whether of sensation or of intellection. These are attributes that reside only in animals, and that reach their highest degree only in man.

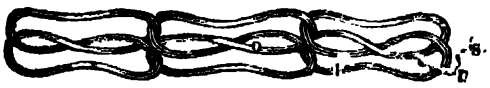
MANUFACTURE OF CHAINS.

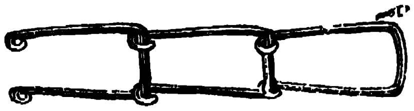
At what period, or under what circumstances, the manufacture of the common kinds of useful chains commenced in this country, we cannot accurately determine. Our countrymen have long been renowned abroad for the fabrication of curious chains, or strings of twisted wire, to which watches, tweezer cases, and trinkets in general used to be suspended These articles were prized and imitated by foreigners as the English chain. Of late years, and in various countries, an endless variety of fancy textures, made of different kinds of wire, have successively made their appearance, the enumeration or description of which would be almost as difficult, as in general an amateur attempt to imitate the chains themselves would be unsuccessful.

Perhaps one of the simplest and almost the weakest forms of chains is that, the links of which are composed by bending a bit of wire into a sort of loop at one end, and bending the other end in like manner, only that the loops make right angles with one another. This is the brass chain usually connected with the smaller scales in retail shops. Made stronger, and of iron, it is used for weighing heavier articles, and as a dog-chain. It is not very different from another well-known chain, the wire composing the links of which is hooked or twisted at the ends, to give the greater strength. It is, however, both less neat and less strong than the links which are made of coils of wire, drawn together in the middle, and then wrapped about with the wire. The next figures are chains made of wire: they are both of considerable antiquity.









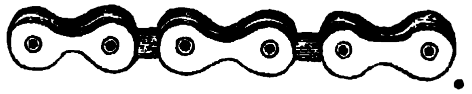
In the manufacture of chains for almost all the ordinary purposes to which they are now applied, the links are either pieces of wire simply bent into the desired form, and the ends of the material brought into such contact with the shank or with each other, that they maintain their connection; or they are soldered together; or, lastly, they are welded in the usual manner of uniting pieces of iron.

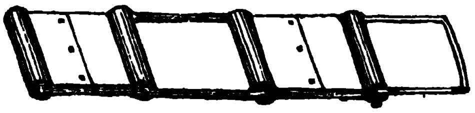
Instead of forging the material for the link out of a light bar of square iron, as was the practice formerly, the general course is to use round iron, which is reduced exactly to the size required by being passed through grooved rollers. The workman takes a rod of this iron heats it in his hearth to a cherry red, and then withdrawing it, he places it upon a chisel, and measuring the length requisite to form a link, gives it a stroke with his hammer, and bends it into the shape of a U. Then taking hold of this half-formed link with his tongs, he inserts it again in the fire; and having brought both points to a welding heat, he unites them by hammering on the beak or point of his anvil, taking up, of course, as he proceeds, in every case the link last formed, which, for the convenience of catching easily, he hangs upon the beak or point of his anvil, while he heats and bends the iron for the next link; and so in succession with each, until his chain be of the length required. The dexterity with which a clever workman performs this process of linking common light chains, can only be conceived of aright by those who have either witnessed this or some similar manufacture.

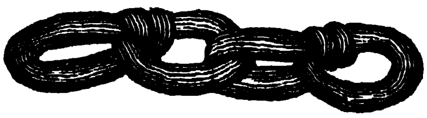
The most common form of the link in chains for ordinary purposes is that of an oval, the stress being, of course, always in the direction of its longer axis; this form, however, is varied according to circumstances, and as lightness or strength becomes indispensable. In the former case, as for traces, the links are generally made considerably oblong; whereas in crane and similar chains, the ovate form is contracted in length as much as is compatible with the free motion of the links in each other. It must be obvious that in common chains, which are continually in use, the principal wear will be on the inner surface of the extremities, where the links are in contact, and with considerable motion when the chain is in use; and hence it was no uncommon thing to see cart traces worn quite through at the ends, while the sides were nearly as stout as when first made. To remedy this evil, a very simple alteration was made; the link, instead of being of uniform substance, as heretofore, was made thicker at the extremity of the oval, and thus the durability of the chain was indefinitely increased. As, however, this method added much to the labour and consequent expense of the article so made, when wrought by the hammer in the ordinary manner, Mr. Hawks, a metropolitan iron master, who introduced this improvement, obtained a patent for manufacturing chains of this description out of iron drawn into the proper form by being passed through rollers, the grooves in which were deeper and shallower, at distances answering to the circumference of a link; so that the maker had merely, as in the case of round rods, to cut off and weld the links in the usual manner. These *knotted* chains, as they are called, are now made by all the chain-makers.

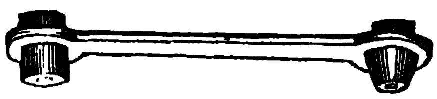
The heaviest traces, and they are generally of the make just described,—are those used with the London dray-horses; the next sort by the Suffolk and Norfolk farmers, for plough traces; and a still lighter kind, called the Edinburgh traces, are used by the Scotch. The Yorkshire traces are mostly of smaller links of the ordinary kind, made out of common round iron. Cart traces are generally about ten feet in length, and weigh, according to the strength, from ten pounds to eighteen pounds per pair. Halter-chains, those used with bridles, and others connected with horses used in husbandry, have generally the links twisted, for which no particular reason, beside the fancy of the parties, seems to be assignable. The "back-band," as the carters designate the chain which, passing over the saddle of the horse, supports the shafts of the vehicle, and partially the load, is always twisted, and made flat and square: it is composed of a double series of links, the whole being, when united, heated in the fire; and after being twisted through the entire length, it is hammered into the square form on the anvil.

Ropes have given way to chains less generally in the working of pits than where both are used for most other purposes. The reason is, that the chain is supposed to break without giving warning, whereas the wear and faults of the rope are generally noticed in time to forestall the danger. Beneath are chains used in collieries: the last of these is a sort of metal rope, intended to answer the purposes of a hempen rope in the working of mines; also for wells and cranes. It was first made in 1790, by Mr. W. Hancock, of Bingham, near Nottingham, and a premium of fifty guineas was presented to him for his invention. It is made of wire three-eighths of an inch thick, twisted into coils. The first of these on the smallest scale represents the chain found in the inside of a common watch. The next cut shows a bar chain, similar in principle to it; it was, in 1805, the patent right of William Hawks, a Durham iron manufacturer, whose invention consisted in making chains by cutting the links out of a flat bar by means of a fly press and proper dies, and then fitting into the holes bushes or thimbles to give them greater strength. A few years afterwards another patent was granted to a Staffordshire ironmaster, of the name of Smith, for producing links of a similar form by means of rollers.









Latterly, the use of ropes has been largely superseded by the adaptation of chains, not merely for cranes, hauling purposes, &c., but especially for cables; large manufactories for chains of this description having been established in London, Liverpool, Hull, Bristol, and other ports. The use of the best material for this purpose had become so important to the shipping interests, that when, in 1825, Mr. Huskisson proposed in parliament, a reduction of the import duty on foreign iron, he laid especial stress on its indispensability in the manufacture of iron cables, which had of late come into very general use in our ships. The honorable gentleman observed, that "a mixture of Swedish iron was considered of great advantage; and those cables in which it was used were considered best. Here, then, (argued the speaker), a most important benefit to our naval interests might be counteracted or prevented, by continuing the present high duties; the reduction of the duty on this article was on every account desirable."

(To be continued.)

SHOWERS OF FLESH AND BLOOD.

Some literary work at Nashville, called the "Banner," in the State of Tenesee, in the United States, has a terrific article under the above frightful heading, exciting a more staring wonderment in the natives there, than the bloody or "*red snow*" did in a recent sketch of the Arctic regions, which latter wonder was accounted for by the most simple and natural means.

So have the "showers of blood," &c. been explained away by a neighbour at Alexandria, as the larvæ of insects, particularly the species *Lœpidoptera* (butterflies).

We will for a moment put the shower of "flesh" on one side, that being only the *garnish* of the dish of horrors.

There is a prolific species of the butterfly on large continents, which, when they emerge from the pupa or chrysalis state, discharge a reddish fluid; and where they are found in great numbers, a considerable extent of ground may have these red spots, exhibiting the appearance of the traces of a night shower. This is no recent discovery. Sleidan, as far back as 1553, describes a multitude of butterflies which swarmed through a great part of Germany, sprinkling plants, leaves, &c. &c. with bloody drops, as if it had rained blood. Reaumur gives a further notice of it, as occurring in the suburbs of Aix, in 1608, when a wide breadth of land was sprinkled in the same manner. A "great sensation" was the first consequence, till a Mr. Pierese, a philosopher of the vicinity, explained the true nature of the phenomenon: a chrysalis, which he had preserved in his cabinet, disclosed the secret. Hearing the fluttering of the insect, when it had arrived at its mature state, he repaired to the spot; he opened the box, and the animal flew out, leaving a red spot behind it. He compared this with other of the "bloody shower," and found them exactly alike; but in this latter case, at Aix, the spots were chiefly found in corners and cavities, where rain could not very conveniently come, and in such places as the insects sought as a refuge. But a very little does with which to start a good story of this sort.

Those who may wish for further information on this subject, in connexion with the amusing history of that happy fluttering and changeful being of the winter's death and the summer's resurrection, with angels' wings into sunny skies—the butterfly,—may consult Comstock's "Physiology," and No. 74 of the "Family Library."

The "flesh" alluded to in the Nashville story, in order to render the monstrosities *en suite*, was most likely a part or portion of some insects that perished in the process of transformation.

MACHINE FOR DRIVING PILES.

A machine for driving a double row of piles, which was constructed at Utica, in the United States, and recently brought over to this country, is now in operation at Smith's timber wharf, Pedlar's Acre, where it can be seen driving the piles for the causeway and abutment on the Surrey side of the New Hungerford Market Bridge, now in progress. The hammers, or weights, or as they are more usually called by the pile-drivers "the monkeys," are elevated to a height of thirty-five feet or thereabouts, along grooves in perpendicular leaders, by means of a locomotive steam engine of ten-horse power, fixed on a platform, on which the whole of the machinery is placed. The power of the blow given by each of these hammers exceeds six hundred tons, and drives a pile of twenty-seven feet long, and as thick as the thickest piles used in embankments and for coffer-dams, nearly its whole length into the earth, in about eight minutes, or perhaps less. It drives two piles at the same time. A circular horizontal saw is worked by the engine, which, in a few seconds, cuts the tops of the piles even, and enables the trucks, or small wheels on which the platform is supported, to come forward as fast as the piles are driven, and cut them even at the top; the platform is propelled by a one-horse power by the engine. The power of this machine is astonishing, and requires to be seen to be fully estimated. It is an important application of steam power, likely to produce very beneficial results in public works, in the formation of sea banks, and in all operations on a large scale where rapidity of execution and precision are required. The machine was used in America for driving piles for rail-roads; and travelled by its own power upwards of two hundred miles, driving piles, and making its own road through swamps and districts heretofore impervious. It is patented in this country, and also in the United States. The machine has, moreover, the power of drawing piles out of the earth as quickly as it drives them in, and can be applied to the raising of blocks of stones, and all heavy weights that require an extraordinary power. —*Times.*

BIRDS,

IN REFERENCE TO GARDENS.

Birds are, upon the whole, much more beneficial than injurious to gardens; and being also larger animals and more familiar to every person living in the country than insects, very little requires to be said respecting them. We shall briefly notice the commonest English birds of the different orders; taking as our guide Jenyns' *Manual of British Vertebrate Animals*.

Raptòres (*Seizers.*)—Birds with feet formed for grasping; food, entirely animal substances. This order includes the eagle and falcon, which may be considered injurious to gardens by scaring away other birds which are useful. It also includes the sparrow-hawk, which preys upon the smaller birds and quadrupeds, and also on amphibiæ; on which account it may be considered as partly injurious and partly useful. This may also be said of the kite. The kestril, or wind-hover hawk is peculiarly valuable for killing beetles, and it also destroys slugs and snails. It is peculiarly fit for a garden, because cats dare not venture to attack it. The white owl, or barn-owl, with tawny yellow plumage, white underneath, is one of the most valuable birds of this order, because it feeds principally upon mice, snails, and slugs, and occasionally devours other small animals, such as rats, and sometimes, but rarely, fish. It is common in every part of the kingdom; it comes abroad about sunset, and collects its food during the night. It may be known from the tawny owl or wood-owl by screaming in its flight, but never hooting like that species. "If this useful bird caught its food by day," Mr. Waterton observes, "instead of hunting for it by night, mankind would have ocular demonstration of its utility in thinning the country of mice, and it would be protected and encouraged everywhere. It would be with us what the ibis was with the Egyptians.

When it has young, it will bring a mouse to the nest about every twelve or fifteen minutes. But in order to have a proper idea of the enormous quantity of mice which this bird destroys, we must examine the pellets which it ejects from its stomach in the place of its retreat. Every pellet contains from four to seven skeletons of mice. "In sixteen months from the time that the apartment of the owl on the old gateway at Walton Hall was cleaned out, there has been a deposit of above a bushel of pellets." The tawny owl, with reddish brown plummage, is found only in woods, where it builds in the hollows of old trees, or amongst ivy. It preys upon various small quadrupeds and birds; it comes abroad only during the night, and has a clamorous and hooting note. By destroying small birds, this owl becomes injurious to the gardener as well as useful, and therefore he ought chiefly to encourage the barn-owl. For this purpose a picturesque tower might be formed in some retired situation in the flower-garden or shrubbery, or on one of the angles of the kitchen-garden wall, like a watch-tower, where it would prove ornamental; and a brood of young owls might be brought to it, and supplied abundantly with mice till they were full-grown, and able to provide for themselves. The time to procure the young birds is about the end of April; or the eggs might be procured and hatched in the bark-bed of the stove, &c. There are some other species of owl occasionally found in England, but they are too rare to be of any practical use.

Insessòres (*Perchers*).—Birds with feet adapted for perching: food, chiefly insects and the smaller quadrupeds, but partly fruits and seeds. This order includes a number of birds which are interesting to gardeners. The shrikes, of which there are two species, feed on small birds, mice, snails, and insects. The fly-catchers feed on insects taken on the wing; and among these the cultivated or hive-bee does not escape. The water ouzel feeds on aquatic insects, and is capable of diving for them. The missel-thrush lives on insects and berries, particularly on those of the mistletoe. The field-fare feeds on haws and other berries, and also on insects and worms. The song-thrush feeds on berries, insects, and snails; as does the blackbird and the redwing. The red-breast feeds on insects and worms; and also, when the food is scarce, on seeds or crumbs of bread. The black-cap lives chiefly on insects; the wag-tail on aquatic insects. The titmouse lives chiefly on insects, but will also eat seeds. The greater titmouse, when hard pressed for food, lives upon the honey-bee; and, according to Mr. Main, sometimes destroys great numbers of them. The bird "seats himself at the door of the hive, and taps with his bill to provoke the bees to come forth. The first bee that comes out is instantly seized by the middle and carried off to a tree, and there beaten against a branch till it is nearly dead. The bird then separates the head and thorax, which it swallows, from the abdomen, which it rejects, as containing the sting, and then flies back for another victim." The bearded titmouse, an inhabitant of fenny districts, lives on snails and other land molluscæ. The lark feeds on insects and small seeds. The Cirl bunting, found in Devonshire and some of the adjoining counties, is said to feed on the berries of the Solánum Dulcamára. The chaffinch, the house-sparrow, the tree-sparrow, and different other species belonging to the genus Fringílla, feed on insects and seeds; sometimes on berries; and when food is scarce, on the buds of trees. They also eat the anthers of crocuses and other spring flowers. In severe winters the buds of the gooseberry and currant tribe are sometimes devoured by the common house-sparrow; and this even in the neighbourhood of London, where it might be supposed this bird would find food at all seasons. The bullfinch, cross-bill, and starling, live on insects and worms, and occasionally grain. The raven lives on mice, rats, poultry and other animals, as well as on carrion. The carrion crow and the hooded crow have similar habits. Mr. Waterton considers the carrion crow as merely a variety of the raven; "he rises long before the rook, and retires to rest later than that bird. Indeed, he is the first bird on wing in the morning, and the last at night, of all our non-migratory, diurnal British birds. He feeds voraciously on ripe cherries, and in autumn eats walnuts; but he destroys many worms and caterpillars; though when his young are in the nest, he seizes game and young poultry wherever he can find them." The rook lives principally on the grub of the cockchafer, the wireworm, and other insects; but will occasionally devour corn; and, during the winter season, is very destructive to turnips. The jackdaw, the jay, and the magpie, feed on a great variety of animal and vegetable substances. The woodpecker of which there are several species, feeds on ants and other insects; more especially on the larva of the timber-eating species, which it extracts by means of its long tongue, after having perforated the wood with its bill. "Neither the titmouse nor the woodpecker," Mr. Waterton observes, "ever bore into the hard and live wood." The wryneck lives principally on ants; and the common creeper which is generally dispersed through the country, and is remarkable for the great facility with which it climbs up the trunks of trees, feeds entirely on insects. The nuthatch lives occasionally on insects, but principally on nuts; which it breaks with its bill after having firmly fixed them in the crevices of old trees. The cuckoo feeds principally on caterpillars and other insects. The swallow and the martin feed entirely on insects taken on the wing; they appear about the end of April or beginning of May, and depart in October. The goatsucker lives on insects, particularly on cockchafers, which it seizes on the wing, and on butterflies; but this bird is more frequently found in solitary woods than in gardens or frequented places.

The greater number of birds which frequent gardens belong to this order; and while they do good by devouring insects, snails, and worms, they are also to a certain extent injurious, by eating fruits and attacking newly-sown or germinating seeds. The singing-birds are the best for destroying soft-winged insects, such as moths and butterflies. Of all the birds of this order, perhaps the hedge-sparrow is the most harmless, and the house-sparrow the most mischievous. The former lives upon the seeds of weeds or other plants that lie upon the surface of the ground, and it rarely attacks buds; while the house-sparrow scratches up newly-sown seeds and crops the tops of seedling plants when they are just penetrating through the surface of the soil, such as peas: it also eats the smaller fruits, and, when other food is wanting, attacks buds. The robin devours currants, more especially about the time the young robins leave the nest, in June, when the currants are beginning to ripen. Blackcaps, whitethroats, and bullfinches, eat currants, strawberries, and raspberries; and of the latter fruit, bullfinches are particularly fond. Gooseberries, being too large for the soft-billed birds, as soon as they ripen are attacked by blackbirds and thrushes; and the fondness of these birds for ripe cherries has long been notorious. The wren and the fly-catcher are purely insectivorous; and the tomtits, though they sometimes destroy buds, yet are far more useful than injurious, from the number of caterpillars which they devour.

Rasòres (*Scratchers*).—Birds with feet not formed for scraping: food, chiefly seeds and terrestrial vermin. The ringdove, and different other species of doves, live on all kinds of grain and seeds, and, during severe weather, on the leaves of turnips and other cultivated plants; and some of them occasionally eat the smaller snails and slugs. This is the case with the domestic pigeon; though it more frequently lives on peas and grain. The turkey lives on snails, slugs, worms, lizards, frogs, and terrestrial insects, together with corn and seeds of almost every other kind. The peacock lives on similar food, and will even attack small snakes. The Guinea pintado, the domestic cock, and the pheasant, are omnivorous, eating roots as well as animals, fruits, and seeds. The corn of Ranùnculus bulbòsus, where it abounds, is greedily eaten by the pheasant. The grouse frequents woods of pines, birch, and juniper, and feeds on the berries of the latter, and on the buds and tender spray of the two former. The black grouse feeds on berries, and on the tops of heath and birch. The common partridge feeds on seeds and insects, and especially on the pupæ of ants. Few of these birds concern the gardener, except the turkey, peacock, and pheasant, which may be useful in pleasure-grounds in picking up vermin.

MEMORANDA.

The Common Watch, it is said, beats or ticks 17,160 times in an hour. This is 411,140 a day, and 150,424,560 a year, allowing the year to be 365 days and six hours. Sometimes watches will run, with care, 100 years. In that case it would last to beat 15,042,456,000 times!

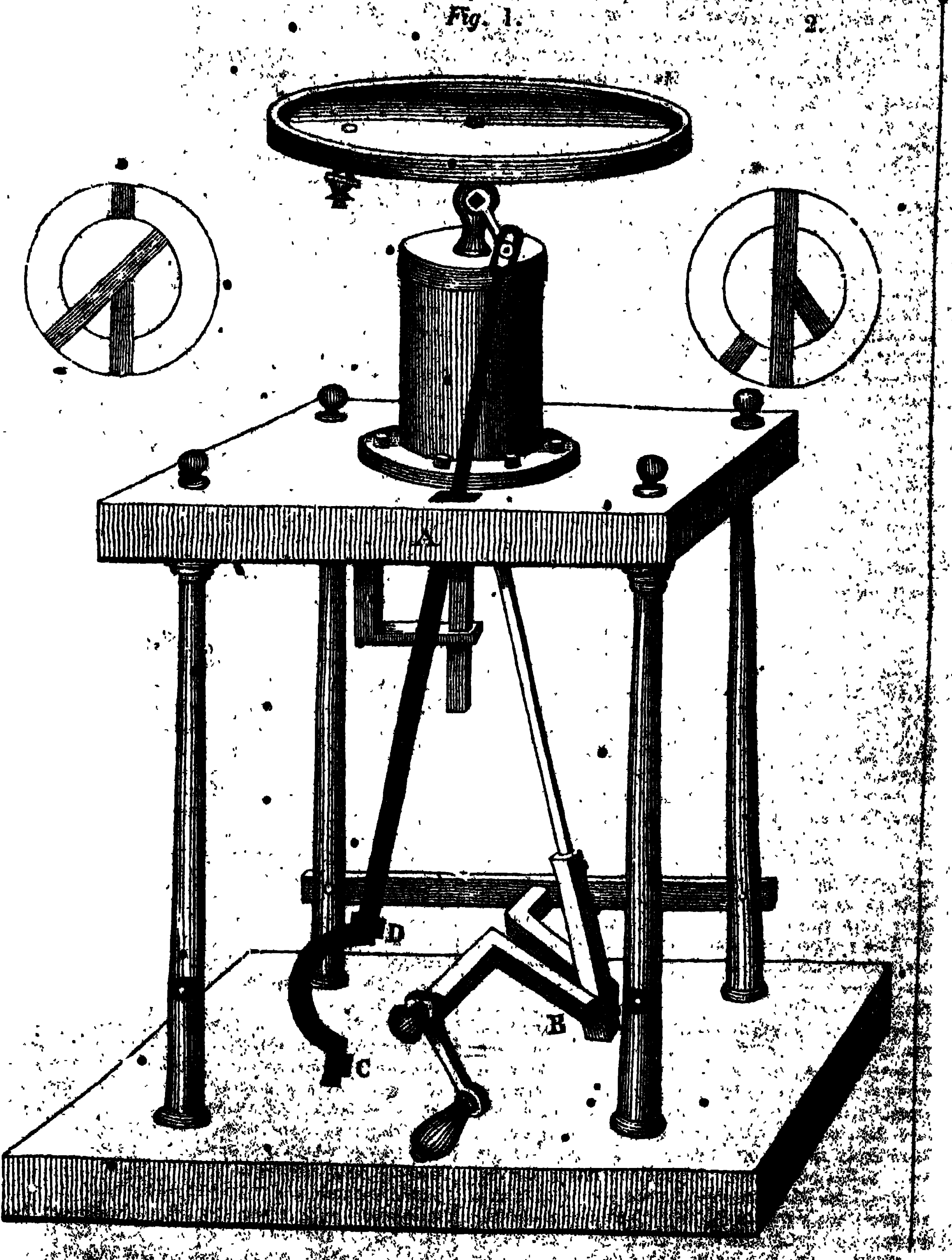
Putridity of Meat.—Until the experiments of the celebrated Italian physician, Redi, who died in 1697, insects were supposed to be engendered in putridity, and not by their own species. The correction of this error first led butchers and housekeepers to guard meats from flies, by defending them with gauze coverings. The most important of Redi's experiments was the following:—He put some meat and fish into a large vessel, covered with very fine gauze, which he also put into a large box, covered with the same gauze, that the air might penetrate to the meats while it remained free from the intrusion of insects. On these he did not see a single worm, but frequently saw the little creatures writhing about on the outer gauze, trying to make their way through; and it was with difficulty that he was once quick enough to prevent two of them from falling on the meat, for they had got their bodies half through the inner gauze. He also observed the flies, attracted by the meat and unable to make their way to it, drop their eggs upon the gauze; some of them alighting upon it, others hovering in the air during the operation; and he perceived that each left six or seven eggs at a time. This was the point he wished to ascertain; and he had now discovered that insects supposed to be engendered by corruption were, in reality, propagated by their own species. During the course of these experiments, Redi ascertained the curious fact, that when the common day-fly dies, it serves as a nest for its own species equally with any other kind of dead flesh.

Draft in Chimneys.—When a fire is lighted in a stove-grate, the air in the chimney over it becomes heated by the fire, and therefore lighter than the external atmosphere, and consequently it ascends. Thus is produced what is called a draft in the chimney, which is merely the upward current of air produced by the ascent of the heated air confined in the flue. When a grate has remained for some time without having a fire in it, the chimney, grate, &c. become cold, and when the fire is first lit, it does not heat the air fast enough to produce a current necessary for the draft; and as the smoke will not ascend, it issues into the apartment. This effect is often attributed to the supposed foulness of the chimney, instead of the above cause; for after the grate and flue become warm, the draft is restored, and the chimney ceases to smoke.

Durability of Bricks.—An impression exists in reference to the want of durability in bricks, as a building material, of the correctness of which a little reflection will convince us there is some doubt, provided they be properly made. So far from being the most perishable, they are the most durable substance; and the bricks of Nineveh and Babylon, in the museums, show that they were selected by the ancients as the most lasting material. Plutarch thinks them superior in durability to stone, if properly prepared; and it is admitted that the baths of Caracalla, those of Titus, and the Thermæ of Dioclesian, have withstood the effects of time and fire better than the stone of the Coliseum, or the marble of the Forum of Trajan: yet the bricks of Nineveh and Babylon (and some of those of the Romans also) were only sun-dried—not baked or burned, as the modern practice is.

Organic Remains.—An interesting discovery has recently been made in Mr. Brewer's quarry, in Boxfield, Box, of fossil bones, which were found in a cavern, seventy feet under the surface, and have the same appearance as the freestone, or oolite, but are much lighter; they are numerous, and amongst them the vertebræ are very distinct, and some large bones like legs, and a head, but there is nothing to indicate that they belong to any existing species. Nothing of the kind has ever before been found in the locality, nor in cutting the Box tunnel, though specimens of vegetables and fish have been found in the inferior oolite, and the clay on which it was recumbent.

A vessel has been constructed by a company in Louisania, to be propelled by carbonic acid gas, on the principle discovered by Telletien and Faraday; the acid being generated in a liquid state, under great pressure. The invention consists in having two large gas generators, on the same plan as that of Tellerin, which are supplied with sesqui-carbonate of soda and sulphuric acid. A few drops of the liquid carbonic acid produced by the mixture of these substances are allowed to drop alternately before and behind the pistons of an engine, contrived like those of a steam engine, and as this liquid acid is at a pressure, of at least 93 atmospheres, its great expansion gives motion to the engine. By this means of propelling ships, a few tons of sesqui-carbonate of soda and sulphuric acid, would be sufficient for a voyage across the Atlantic.—*Le Fanal.*



WAGSTAFF'S AIR-PUMP.

WAGSTAFF'S AIR-PUMP.

SIR.—By the circumstance of seeing a receiver thrown off the plate of an air-pump, through a slight mistake or miss-turn of the tap, I was led to think about constructing an air pump that would produce a vacuum by a single movement, and not be liable to such mistakes: I have at length accomplished my object, and, although it is on a very small scale, the effect produced fully answers my expectation. If the following description meets your approbation, by giving it a place in the Magazine you will oblige yours, P. WAGSTAFF.

Manchester.

The stand is a piece of mahogany, 7½ inches by 5½, into which are fixed four uprights; at the height of 7 inches is another stout piece of wood, 5 inches by 4; on the centre of this stands the cylinder, 3 inches high, 1½ bore, open at bottom; the top is closed, and furnished with a tap, the construction of which is seen at Figs. 2 and 3; on the top of this is screwed the pump-plate, 5 inches in diameter. Two inches above the stand are two cross-pieces, (the front one, and the handle by which the pump is worked being removed that the other parts may be seen,) through which passes a spindle; on this is a crank of 1 inch eccentricity. The centre of the crank is perpendicular to the centre of the cylinder. The crank carries a collar, to which are screwed two connecting rods; these take hold of the piston-rod just below the piston; they work on each side of a stud, through which the piston-rod works, and is thus kept perpendicular. The plug of the tap projects over the top of the cylinder, and on it is a lever: at 1 inch from the centre of the tap is a pin with a small friction roller—this is moved from side to side by the long lever which is centered at A. B is a pin in the side of the crank. Now suppose the crank and piston to be at the top, and the tap in the position seen at Fig. 2; the piston is then drawn down, and the air in the receiver expands to fill the cylinder. When the crank gets near the bottom, the perpendicular motion is inconsiderable, but the horizontal motion is sufficient to move the lever about an inch by the pin B catching on C, which is a projection inside the lever. The tap is now in the position seen at Fig. 3. The passage is now cut off from the pump plate, and another opened to the atmosphere. The piston is now raised, and drives out the air; when the crank is near the top, the pin B meets D; another projection inside the lever drives it about an inch, moving the tap to its former position. Thus the operation is continued at pleasure.

The ways in the tap are small, that they may retain as little air as possible, and that a small movement may shut one way from the other.

SLIDE OF ALPNACH.

AMONGST the forests which flank many of the lofty mountains of Switzerland, some of the finest timber is found in positions almost inaccessible. The expense of roads, even if it were possible to make them in such situations, would prevent the inhabitants from deriving any advantages from these almost inexhaustible supplies. Placed by Nature at a considerable elevation above the spot at which they can be made use of, they are precisely in fit circumstances for the application of machinery to their removal; and the inhabitants avail themselves of the force of gravity to relieve them from some portion of this labour.

Of all these specimens of carpentry, the Slide of Alpnach was the most considerable, from its great length, and from the almost inaccessible position from which it descended. The following account of it is taken from Gilbert's Annalen, 1819, which is translated in the second volume of Brewster's Journal:—

"For many centuries, the rugged flanks and the deep gorges of Mount Pilatus were covered with impenetrable forests; which were permitted to grow and to perish, without being of the least utility to man, till a foreigner, who had been conducted into their wild recesses in the pursuit of the chamois, directed the attention of several Swiss gentlemen to the extent and superiority of the timber. The most skilful individuals, however, considered it quite impracticable to avail themselves of such inaccessible stores. It was not till the end of 1816, that M. Rupp, and three Swiss gentlemen, entertaining more sanguine hopes, purchased a certain extent of the forests, and began the construction of the slide, which was completed in the spring of 1818.

"The Slide of Alpnach is formed entirely of about 25,000 large pine trees, deprived of their bark, and united together in a very ingenious manner, without the aid of iron. It occupied about 160 workmen during eighteen months, and cost nearly 100,000 francs, or 4,250*l*. It is about three leagues, or 44,000 English feet long, and terminates in the Lake of Lucerne. It has the form of a trough, about six feet broad, and from three to six feet deep. Its bottom is formed of three trees, the middle one of which has a groove cut out in the direction of its length, for receiving small rills of water, which are conducted into it from various places, for the purpose of diminishing the friction. The whole of the slide is sustained by about 2,000 supports; and in many places it is attached, in a very ingenious manner, to the rugged precipices of granite.

"The direction of the slide is sometimes straight, and sometimes zig-zag, with an inclination of from 10° to 18°. It is often carried along the sides of hills and the flanks of precipitous rocks, and sometimes passes over their summits. Occasionally it goes under ground, and at other times it is conducted over the deep gorges by scaffoldings 120 feet in height.

"The boldness which characterizes this work, the sagacity and skill displayed in all its arrangements, have excited the wonder of every person who has seen it. Before any step could be taken in its erection, it was necessary to cut several thousand trees to obtain a passage through the impenetrable thickets. All these difficulties, however, were surmounted, and the engineer had at last the satisfaction of seeing the trees descend from the mountain with the rapidity of lightning. The larger pines, which were about a hundred feet long, and ten inches thick at their smaller extremity, ran through the space of *three leagues*, or nearly *nine miles*, *in two minutes and a half*, and during their descent, they appeared to be only a few feet in length. The arrangements for this part of the operation were extremely simple. From the lower end of the slide to the upper end, where the trees were introduced, workmen were posted at regular distances, and as soon as every thing was ready, the workman at the lower end of the slide cried out to the one above him, "*Lachez*" (Let go). The cry was repeated from one to another, and reached the top of the slide in *three* minutes. The workmen at the top of the slide then cried out to the one below him, "*Il vient*" (It comes), and the tree was instantly launched down the slide, preceded by the cry which was repeated from post to post. As soon as the tree had reached the bottom, and plunged into the lake, the cry of *Lâchez* was repeated as before, and a new tree was launched in a similar manner. By these means a tree descended every five or six minutes, provided no accident happened to the slide, which sometimes took place, but which was instantly repaired when it did.

"In order to show the enormous force which the trees acquired from the great velocity of their descent, M. Rupp made arrangements for causing some of the trees to spring from the slide. They penetrated by their thickest extremities no less than from eighteen to twenty-four feet into the earth; and one of the trees having by accident struck against another, it instantly cleft it through its whole length, as if it had been struck by lightning.

"After the trees had descended the slide, they were collected into rafts upon the lake, and conducted to Lucerne. From thence they descended the Reuss, then the Aar to near Brugg, afterwards to Waldshut by the Rhine, then to Basle, and even to the sea when it was necessary.

"It is to be regretted that this magnificent structure no longer exists, and that scarcely a trace of it is to be seen upon the flanks of Mount Pilatus. Political circumstances having taken away the principal source of demand for the timber, and no other market having been found, the operation of cutting and transporting the trees necessarily ceased."

ATMOSPHERIC REFRACTION AND REFLECTION.

(Resumed from page 264, and concluded.)

Some very singular appearances occur from the accidental expansion or condensation of the strata of the atmosphere contiguous to the surface of the earth, by which distant objects, instead of being elevated, are depressed. Sometimes, being at once both elevated and depressed, they appear double, one of the images being direct, and the other inverted. In consequence of the upper edges of the sun and moon being less refracted than the lower, they often appear to be oval when near the horizon. The looming also, or elevation of coasts, mountains, and ships, when viewed across the sea, arises from unusual refraction. Single and double images of objects at sea, arising from sudden changes of temperature, which are not so soon communicated to the water on account of its density as to the air, occur more rarely, and are of shorter duration than similar appearances on land. In 1818, Captain Scoresby, whose observations on the phenomena of the polar seas are so valuable, recognized his father's ship by its inverted image in the air, although the vessel itself was below the horizon. He afterwards found that she was seventeen miles beyond the horizon, and thirty miles distant. Two images are sometimes seen suspended in the air over a ship, one direct and the other inverted, with their topmasts or their hulls meeting, according as the inverted image is above or below the direct image. Dr. Wollaston has proved that these appearances are owing to the refraction of the rays through media of different densities, by the very simple experiment of looking along a red hot poker at a distant object. Two images are seen, one direct and another inverted, in consequence of the change induced by the heat in the density of the adjacent air. He produced the same effect by a saline or saccharine solution with water and spirit of wine floating upon it.

Many of the phenomena that have been ascribed to extraordinary refraction seem to be occasioned by a partial or total reflection of the rays of light at the surfaces of strata of different densities. It is well known, that when light falls obliquely upon the external surface of a transparent medium, as on a plate of glass, or stratum of air, one portion is reflected and the other transmitted. But when light falls very obliquely upon the internal surface, the whole is reflected and not a ray is transmitted. In all cases the angles made by the incident and reflected rays with a perpendicular to the surface being equal. As the brightness of the reflected image depends on the quantity of light, those arising from total reflection must be by far the most vivid. The delusive appearance of water, so well known to African travellers, and to the Arab of the desert, as the Lake of the Gazelles, is ascribed to the reflection which takes place between strata of air of different densities, owing to radiation of heat from the arid sandy plains. The mirage described by Captain Mundy, in his Journal of a "Tour in India," probably arises from this cause. "A deep precipitous valley below us, at the bottom of which I had seen one or two miserable villages in the morning, bore in the evening a complete resemblance to a beautiful lake; the vapour, which played the part of water, ascending nearly half way up the sides of the vale, and on its bright surface trees and rocks being distinctly reflected. I had not been long contemplating the phenomenon, before a sudden storm came on and dropped a curtain of clouds over the scene."

An occurrence which happened on the 18th of November, 1804, was probably produced by reflection. Dr. Buchan, while watching the rising sun from the cliff about a mile to the east of Brighton, at the instant the solar disc emerged from the surface of the ocean, saw the cliff on which he was standing, a windmill, his own figure, and that of a friend, depicted immediately opposite to him on the sea. This appearance lasted about ten minutes, till the sun had risen nearly his own diameter above the surface of the waves. The whole then seemed to be elevated into the air and successively vanished. The rays of the sun fell upon the cliff at an incidence of 73° from the perpendicular, and the sea was covered with a dense fog many yards in height, which gradually receded before the rising sun. When extraordinary refraction takes place laterally, the strata of variable density are perpendicular to the horizon, and if combined with vertical refraction, the objects are magnified as when seen through a telescope. From this cause, on the 26th of July, 1798, the cliffs of France, fifty miles off, were seen as distinctly from Hastings as if they had been close at hand; and even Dieppe was said to have been visible in the afternoon.

The stratum of air in the horizon is so much thicker and more dense than the stratum in the vertical, that the sun's light is diminished 1300 times in passing through it, which enables us to look at him when setting without being dazzled. The loss of light, and consequently of heat, by the absorbing power of the atmosphere, increases with the obliquity of incidence. Of ten thousand rays falling on its surface, 8123 arrive at a given point of the earth if they fall perpendicularly; 7024 arrive, if the angle of direction be fifty degrees; 2831, if it be seven degrees; and only five rays will arrive through a horizontal stratum. Since so great a quantity of light is lost in passing through the atmosphere, many celestial objects may be altogether invisible from the plain, which may be seen from elevated situations. Diminished splendour, and the false estimate we make of distance from the number of intervening objects, lead us to suppose the sun and moon to be much larger when in the horizon than at any other altitude, though their apparent diameters are then somewhat less. Instead of the sudden transitions of light and darkness, the reflective power of the air adorns nature with the rosy and golden hues of the Aurora and twilight. Even when the sun is eighteen degrees below the horizon, a sufficient portion of light remains to show that, at the height of thirty miles it is still dense enough to reflect light. The atmosphere scatters the sun's rays, and gives all the beautiful tints and cheerfulness of day. It transmits the blue light in greatest abundance; the higher we ascend, the sky assumes a deeper hue; but in the expanse of space, the sun and stars must appear like brilliant specks in profound blackness.

AQUA TINTA ENGRAVING.

The art of engraving on copper, after the manner of Indian ink, by which happy imitations are made of figures that have been drawn with the pencil in Indian Ink, bistre, sepia, &c., particularly those which are on a large scale. There are several sorts of it. In the first, after the outlines of the figure have been etched, finely powdered mastic (*colophonium*) is sifted over the plate, which is then warmed over coals, that the mastic may be melted. In this way, insensible spaces are formed between the particles of mastic, upon which the nitric acid is afterwards to act. The work then goes on as in the mezzo-tinto, only that the scraper is used in this, and the pencil in that; and all the places where there is to be no work or shade, are covered with a thick black varnish, on which the acid does not act. The nitric acid is now poured on, and left to stand as long as is necessary for the lightest shade—about five minutes. The light shades are now stopped out with varnish, and the acid allowed to act a second time, and this stopping out is continued till we come to the deepest shades, which are bit in last. This method is best for historical and architectural subjects; but in landscapes, in which the trees require more freedom of the pencil, the second is used. In this, a good etching ground is spread over the plate, and covered by means of hair-pencil, with oil of lavender or oil of turpentine, to which lamp-black is sometimes added. The oil softens the ground, which may be wiped off with a fine linen cloth, leaving all the marks made with the pencil apparent on the copper. Then, as in the first process, fine mastic is sifted over the plate, melted in and etched. This operation may be repeated many times, according as there are more or fewer tints in the original. By a happy union of both sorts, this style of engraving is carried to a high degree of perfection, and is particularly adapted to express the coloring of the air, where large surfaces are often represented of one tint. In France and Switzerland, the *roulette* is used—a little wheel or roller of steel, with a rough surface and several prominences, which, when it is rolled back and forth on the plate, deepens the excavations made by the acid. They have roulettes of all degrees of size and fineness, to make deeper or more shallow impressions on the plate. From time to time, the particles separated by this process are removed with a scraper. The aqua tinta mode was first introduced a short time since into Britain and Germany; and the British, particularly since Gilpin brought the art into notice, have adorned their literary works in this

STEAM AND THE STEAM ENGINE.

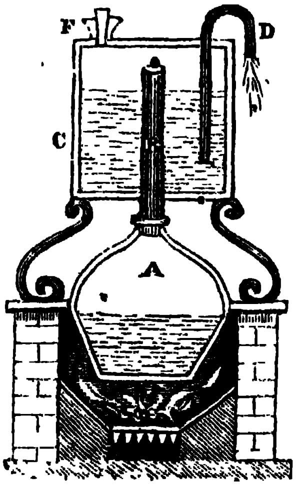
(*Resumed from page* 269.)

From the time of Hero until a comparatively late period no improvement appears to have been made in the application of steam; yet if nothing can be added to the history of this mighty agent, a slight interest is attached to the fact, that a knowledge of its power was not extinct, some of its effects being dreaded by the lime burners of that period. "In the heart of some stones," according to Alberti, who wrote in 1412, "there are certain voids and concavities, in which air being shut up, does sometimes produce incalculable mischief; for when they come to be touched by the fire, and the stone grows hot, it turns to *vapour*, and, bursting the prison in which it is confined, with a tremendous noise, blows up the whole kiln with a force altogether irresistible."

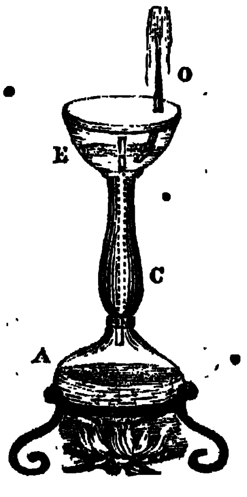
The cause why so many facts, known to the ancients, and those of the power of steam among the number, should have been left unimproved for so many ages, is to be accounted for by the strange character of the philosophers of the period, in which profound knowledge was blended with the grossest absurdities; when the mass of mankind, unable to appreciate useful inventions while in the infancy of them, were led away by those gross impositions of priestcraft and self-styled philosophy which overrun the half-civilized world for so many ages. This state of things is well exemplified in the life of Cardan, who united the most transcendant attainments with the most consummate quackery; profound sagacity with the weakest superstition; who is seen drawing on one page the Horoscope of Christ, and in another imploring his forgiveness for the sin of having eaten a partridge on a Friday, unfolding the most beautiful relations in algebraic analysis, and foretelling from the appearance of specks on his nails his approach to some discovery; above all, eloquent in enforcing the obligations of a pure religion, and expressing the finest sentiments in morals, while his long life was one continued exertion, grossly outraging both. Here this philosopher, juggler, and madman, is entitled to brief mention, from displaying in his writings a knowledge of what has been called the "capabilities" of steam, and more particularly with the fact of a *vacuum* being speedily procured by its *condensation*. He also early recommended that the heated fuliginous vapour "which escaped from every hearth should be turned to a more profitable account;" and in a later book (1557) he gave a description and rude diagram of a machine, moved by heated air, which, since his time, has received no improvement, although much employed, and well known as the *smoke-jack*.

The next author who mentions the power of steam is Mathesius, a German, who, in a sermon preached in 1571, spoke of an apparatus giving an illustration of the "mighty effects which could be produced by the volcanic force of a little imprisoned vapour." Following in the same track, about 1577 another German writer substituted steam for air, in what is called the whirling Æolipile, as we have already more than once figured and described. These contrivances, however, possessed but little invention, novelty or utility, being but very slight modifications of those instruments long previously suggested by Hero, as will be seen by the following illustrations of some of them. Still they are not to be neglected, because they are steps in the history and application of this great agent—*steam*.

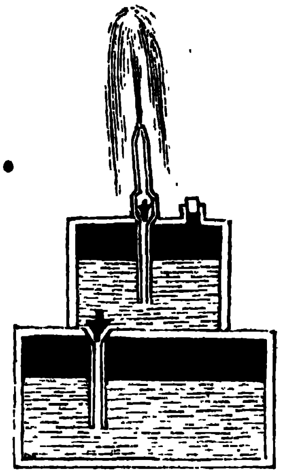
The celebrated Baptista Porta (1606), an Italian philosopher, inventor of the camera obscura, was the author of several ingenious works, and, among others, a commentary on the "Pneumatica of Hero," in which he describes and gives a drawing of a *steam fountain*, which wanted nothing but "the idea of such an application," and the proportional magnitude, to form a steam engine for raising water. It will be understood from the adjoining cut:—



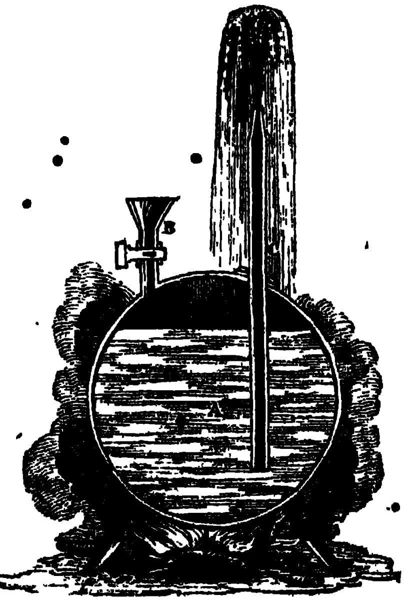
A is a boiler, in which steam is forming; it passes by the pipe B into the cistern C, closed at the top, and nearly filled with water; the pipe B coming above the surface of the water. The steam from the boiler is thus conducted into the space above the water, and pressing on the water by its elastic power, forces it through the tube D. F is a pipe whereby fresh water may be admitted to the cistern. The idea of Porta was neglected for half a century, till Kircher, in 1656, re-invented the same machine, or appropriated it to his own merit. The following is the form given to Kircher's steam fountain, and although it is neater in appearance than Porta's, yet the identity of the principle of the two is very evident. A is the boiler, C the steam-pipe, E the cistern, and O the jet of water.



It may be, however, that Kircher took his invention from De Caus or Branca, who published their discoveries at the period intervening between the time of Porta and Kircher. The former of these philosophers, De Caus, like most other philosophers of this period, was struck with the marvellous hydraulic and pneumatic machines of Hero, and aimed, as others had done before him, to imitate them. One of these contrivances he has given, as illustrative of the fountain; instead of the ball in Hero's problem, De Caus substitutes a box for the water, with lenses inserted into its lid, to increase the sun's heat by concentrating his rays; and in another diagram he places the glasses in a frame, and throws the sunbeams on the outside. The pipe going from the cistern to the heated vessel he furnished with a valve, opening upwards, to prevent the return of the water; another valve is placed in a pipe, leading from the heated vessel, also to perform the same office. As might have been expected the effect is greatly enlarged in this improved apparatus. Hero was satisfied to make the water he raised a small distance fall in drops: De Caus elevated his to an imposing height, and it descended in copious jets.



Another machine of a similar kind, described by De Caus, in 1615, is perhaps the *first* instance in which steam was proposed to be used as a moving power on a large scale, in the manner in which it is now applied, namely, by its elastic force when confined. His theorem is, that water may be raised by the aid of fire higher than its own level; in illustration of which, he gives the following figure and description:—



Take a ball of copper, marked A, well soldered at every part. It must have a vent hole, marked B, to put in the water, and also a long tube, which is soldered into the top of the ball, and the end approaches near to the bottom without touching it. After filling this ball with water, through the vent hole, stop it close, and put it on the fire; then the heat striking against the said ball will cause all the water to rise through the tube. The steam formed by the evaporization of the water having no exit, will accumulate until it has sufficient elastic force to press on the surface of the water so strongly as to cause part of the water to ascend through the tube, and by continuing the heat thus, all the water may be expelled, as De Caus says. "This," says Farey, "is all that De Caus has left us on the subject of steam." De Caus distinctly mentions this power as a means of raising water along with other plans which were in actual operation for that purpose, so that he must have considered it fit for purposes of utility, and thus very probably has given the hint to others.

(To be continued.)

STUTTERING; ITS CAUSE AND CURE.

(*From Arnott's "Elements of Physics."*)

STUTTERING, stammering, or hesitation of speech, are terms implying an interrupted articulation, accompanied generally with more or less of straining and distortion of feature. It is remarkable with respect to this defect, that when the present work was first published, scientific or regular medicine had taught as yet no certain cure for it, although the frequent success of non-professional, and often ignorant individuals, by a mode of treatment which they solemnly bound their patients not to divulge, proved the cure in certain cases, to be both possible and not difficult.—The author's attention had been drawn to the subject some years before, by an interesting case submitted to him, of stuttering connected with other disease; and it was in analyzing the subject with a view to the treatment of that case, that he framed the analysis of articulation contained in the preceding pages, and drew up a part of the additional observations which are now to follow. A cure was obtained; but as the case possessed a favorable peculiarity in the powerful mind of the individual, to which the author attributed great importance, and as he had little leisure from his ordinary professional duties to pursue the subject, or to ascertain in what respects his plan might differ from that employed by the most successful of the practitioners who concealed their proceedings, he gave his remarks in former editions of this work, merely as continued elucidation of the subject of speech. He is now, however, enabled to state, that his analysis has completely detected the nature of the morbid affection, and that it directs simple and effectual means of relief.

The most common case of stuttering, however, is not, as has been most universally believed, where the individual has a difficulty in respect to some particular letter or articulation, by the disobedience of the parts of the mouth which should form it to the will or power of association, but where the spasmodic interruption occurs altogether behind or beyond the mouth, viz. in the glottis, so as to affect all the articulations equally. To a person ignorant of anatomy, and therefore knowing not what or where the glottis is, it may be sufficient explanation to say, that it is the slit or narrow opening at the top of the windpipe, by which the air passes to and from the lungs, being situated just behind the root of the tongue. It is that which is felt to close suddenly in hiccup, arresting the ingress of air, and that which closes, to prevent the egress of air from the chest of a person lifting a heavy weight or making any straining exertion; it is that also, by the repeated shutting of which a person divides the sound in pronouncing several times, in distinct and rapid succession, any vowel, as o, o, o, o. Now, the glottis, during common speech, needs never be closed, and an ordinary stutterer is instantly cured, if by having his attention properly directed to it, he can keep it open. Had the edges or thin lips of the glottis been visible, like the external lips of the mouth, the nature of stuttering would not so long have remained a mystery, and the effort necessary to the cure would have been suggested to the most careless observer: but because they were hidden, and professional men had not detected in how far they were concerned, and the patient himself had only a vague feeling of some difficulty, which after straining, grimace, gesticulation, and sometimes almost general convulsion of the body, gave way, the uncertainty with respect to the subject has remained. Even many persons who by attention and much labor had overcome the defect in themselves, as Demosthenes did, have not been able to describe to others the nature of their efforts, so as to ensure imitation: and evidently the quacks who have succeeded in relieving many cases, but in many also have failed, or have given only temporary relief, have not really understood what precise end in the action of the organs their imperfect directions were accomplishing.

Now, a stutterer, understanding of anatomy only what is stated above, will comprehend what he is to aim it, by being farther told, that when any continued sound is issuing from his mouth, as when he is humming a single note or a tune, the glottis is necessarily open, and therefore, that when he chooses to begin pronouncing or droning what we have already described to be the simplest of vocal sounds, namely, the vowel *e*, and in its less distinct modification, as heard in the English word *certain*, or in the French word *que* (to do which at once no stutterer has difficulty), he thereby opens the glottis, and renders the pronunciation of any other sound easy:—or if, when speaking or reading, he joins his words together, nearly as a person joins them in singing (and this may be done without its being at all noted as a peculiarity of speech, for many persons do it in their ordinary conversation), the voice never stops, the glottis never closes, and there is of course no stutter. The author has given merely this explanation or lesson, with examples, to persons who before would have required half an hour to read a page, but who immediately afterwards read it quite smoothly; and who then, on transferring the lesson to the speech, by continued practice and attention, obtained the same facility with respect to it. There are many persons not accounted peculiar in their speech, who in seeking words to express themselves, or while coming to a decision, often rest between their words on the simple sound of *e* mentioned above, saying, for instance, hesitatingly, "e...... I e...... think e...... I shall,"—the sound never ceasing until the end of the sentence, however long it may be delayed. Now, a stutterer, who, to open his glottis at the beginning of a phrase, or in the middle after any interruption, uses such a sound, would not even at first be more remarkable than a drawling speaker, and he would only require to drawl for a little while, until practice facilitated his command of the other sounds. Although producing the simple sound mentioned is a means of opening the glottis, which by stutterers is found very generally to answer, there are cases in which other such means may be more suitable, as the intelligent preceptor will soon discover. Were it possible to divide the nerves of the muscles which close the glottis, without at the same time destroying the faculty of producing voice, such an operation would be an immediate and certain cure of stuttering.

While the spasmodic closure of the glottis, as above described, is the common cause of stuttering, there are also cases in which the cause is a spasmodic prolongation of some of the aspirates or semi-vowel sounds, as of *s*, *m*, *l*, &c. Fortunately, however, the substitution of the simple sound is equally the cure for all.

While the cure of many stutterers has been accomplished by their own efforts, after the study of what is written in this section, for others, and particularly for young people, the following have been found to be farther useful rules or forms of direction; and a commentary upon them making them perfectly intelligible, would seem to comprehend all that can be communicated upon the subject.—1. Familiarise yourself with the idea of a *continued sound*, as of the roar of the sea or waterfall, or the note of an organ-pipe, and feel that your speech is to be as uninterrupted.—2. Then never stutter more, but substitute always the simple continued sound for any threatened defect, and rest upon it until power be felt to overcome the difficulty.—3. Never repeat words or syllables.—4. The simple sound must become the first syllable (*closely* joined) of every difficult word, until the morbid habit be weakened. The object of all these directions is to enable the patient, first, to substitute universally the *drawl* for the *stutter*, and then, as soon as possible, to discard the *drawl* too.

The view given above of the nature of stuttering and its cure, explains the following facts, which to many persons have hitherto appeared extraordinary. Stutterers often can sing well, and without any interruption; for the tune being continued, the glottis does not close.—Many stutterers can also read poetry well, or any declamatory composition, in which the uninterrupted tone is almost as remarkable as in singing.—A person who draws in a deep breath before beginning to speak, as he cannot long retain the air, and the glottis must be open to let it escape, is to a degree secured against the occurrence of stuttering. The secret remedy of an American quack, who, years ago, got much money from Englishmen, was the direction thus to fill the chest before beginning to speak. A Dr. McCormac, also, who published a work on this subject, founded on the erroneous idea that stuttering was an effort to speak while *inhaling* air, instead of while *exhaling*, gave the same direction.—The cause of stuttering being a weak and easily disturbed association of certain muscular actions, we have the reason why any degree of anxiety or dread as to speaking well exceedingly increases the defect; and why many stutterers, who cannot make themselves intelligible in society, still, when alone, can speak and read as perfectly as any other person. This explains also why many stutterers, who have gone to live for a time at the houses of pretended curers of their defect, have felt themselves singularly relieved from the moment of entering the house; because, knowing that they were expected to speak ill, they had no fear of disagreeably attracting attention, and therefore had their powers much more at command. These persons, on returning to the world, have generally stuttered as badly as ever, but many of the asserted cures of stuttering, with certificates obtained from the parties at the time, have been of the nature now described.—The cause of stuttering being so simple as above described, one rule given and explained, may, in certain cases, instantly cure the defect, however aggravated, as has been observed in not a few instances; and this explains also why an ignorant pretender may occasionally succeed in curing, by giving a rule of which he knows not the reason, and which he cannot modify to the peculiarities of other cases.—The same view of the subject explains why the speech of a stutterer has been correctly compared to the escape of liquid from a bottle with a long narrow neck, coming—"either by hurried gushes or not at all:" for when the glottis is once opened, and the stutterer feels that he has the power of utterance, he is glad to hurry out as many words as he can, before the interruption recurs.

STRAW PLAT.

The culm or stalk of different species of grass is now so commonly applied in this country as a material for making hats and bonnets, that its introduction might naturally be supposed to be of ancient date. It is, however, scarcely half a century since the simple art of platting straws together was first practised to any considerable extent by our rustic population. Immediately previous to the introduction of straw hats, those made of chip were usually worn by our fair countrywomen; and the first rude attempts of our own manufactories were then rejected by the higher classes for the more finished productions of Italy. The coarse British plat was, however, adopted by the more humble in the middle ranks of society, and the home manufacfacture gradually increased in importance. This originated in Scotland, but a work in which even children could be profitably employed, and which they could soon learn to perform with considerable skill and dexterity, was quickly introduced into some of our English counties, and the wives and children of the peasantry of Buckinghamshire, Hertfordshire, and especially Bedfordshire, gradually became engaged in an occupation which required so little instruction. Dunstable plat soon became noticed as the best produced in England; it still retains its place, and continues to give its name to English straw hats of superior quality.

The first marked improvement in British plat consisted in interlacing straw previously split into fine and similar strips; the culm used for this purpose in the infancy of the manufacture having been thick and of unequal sizes, producing a very coarse and uneven plat. From that period this branch of domestic industry has increased rapidly in England. Many other great improvements have been made in the material and manufacture of this article since its first introduction; and many are the varieties of fancy straw plat which have, each in their turn for a brief period been adopted by those fickle patronesses the votaries of fashion. All plats must, however, give place to that of Italy, which is still considered superior to any other. Numerous attempts have been made, at various times, to equal the Italian plat; but although this manufacture is apparently so easy of imitation, yet perhaps neither the French nor English have ever produced any thing fully equal to the Italian hats of the best quality. These are well known in trade as Leghorn straw, so called from the port whence they are exported; but they are in reality manufactured throughout Tuscany, and more especially in the vale of Arno, where the female peasantry find full and profitable employment in this occupation. At every cottage door women and children are to be seen busily engaged picking and platting straws; and even when taking their walks they generally continue the easy work of platting.

Besides the great consumption in Europe of this well-known article, large quantities are sent to the North American states. An intelligent traveller has observed, on witnessing the Tuscan peasantry thus occupied, that "the work produces at every step the pleasing appearance of labour united to amusement, —of a toil in which childish play and childish gains form children to habits of industry without exhausting their strength or gaiety." The women and children in nearly every part of Tuscany wear large straw hats, entirely prepared and made by themselves. These give them a very neat appearance; but altogether the peasantry of this state seem to be in a better condition than those of any other part of Italy. They owe this superiority rather to their own industrious, frugal habits, than to any material difference of government or taxation. The material of which the plat is made is sometimes prepared from the straw of rice and of rye or darnel grass. But the straw principally used is the culm of a kind of red wheat, very commonly cultivated in the Tuscan states. It is a variety of spelt corn, or red wheat (*triticum spelta*), having somewhat the appearance of barley; the grains grow in the ears in a similar manner, but their shape is like that of other wheat.

Although apparently a very simple process, some skill and patience are required to prepare, split, and plat the straw, and to perform all the other operations without breaking so fragile a material. The wheat is allowed to grow till just ready to burst into ear. The straw is then pulled up by the roots, which, as well as the ear, is cut off from every stem; as soon as cut, it is tied in small bundles, immersed for a short time in boiling water, and spread out to dry. This being done, the knots are cut off, and the most slender straws are put aside to be platted whole, from which the best and most durable hats are made. The others are split longitudinally, with the point of a penknife, into two or three parts. These are again moistened and pressed flat for three or four hours, and they are then ready for platting. When hats of an extraordinary fineness are to be made, the straws are divided into a greater number of strips; the point of a knife cannot, however, be depended upon in so minute a division. A row of very fine small needles are connected together at their heads with rosin, the distance from each other being regulated by the degree of fineness to which the straw is required to be divided. A flattened strip is then passed through these needles, which readily divide it to almost any degree of assignable exility. Another contrivance is used in England for dividing the straw. This is the frustum of a small hollow cone the lesser end of which has a number of sharp teeth fixed in its opening. These cut the straw as it is pushed through the cone into strips more or less fine, according to the number and proximity of the teeth.

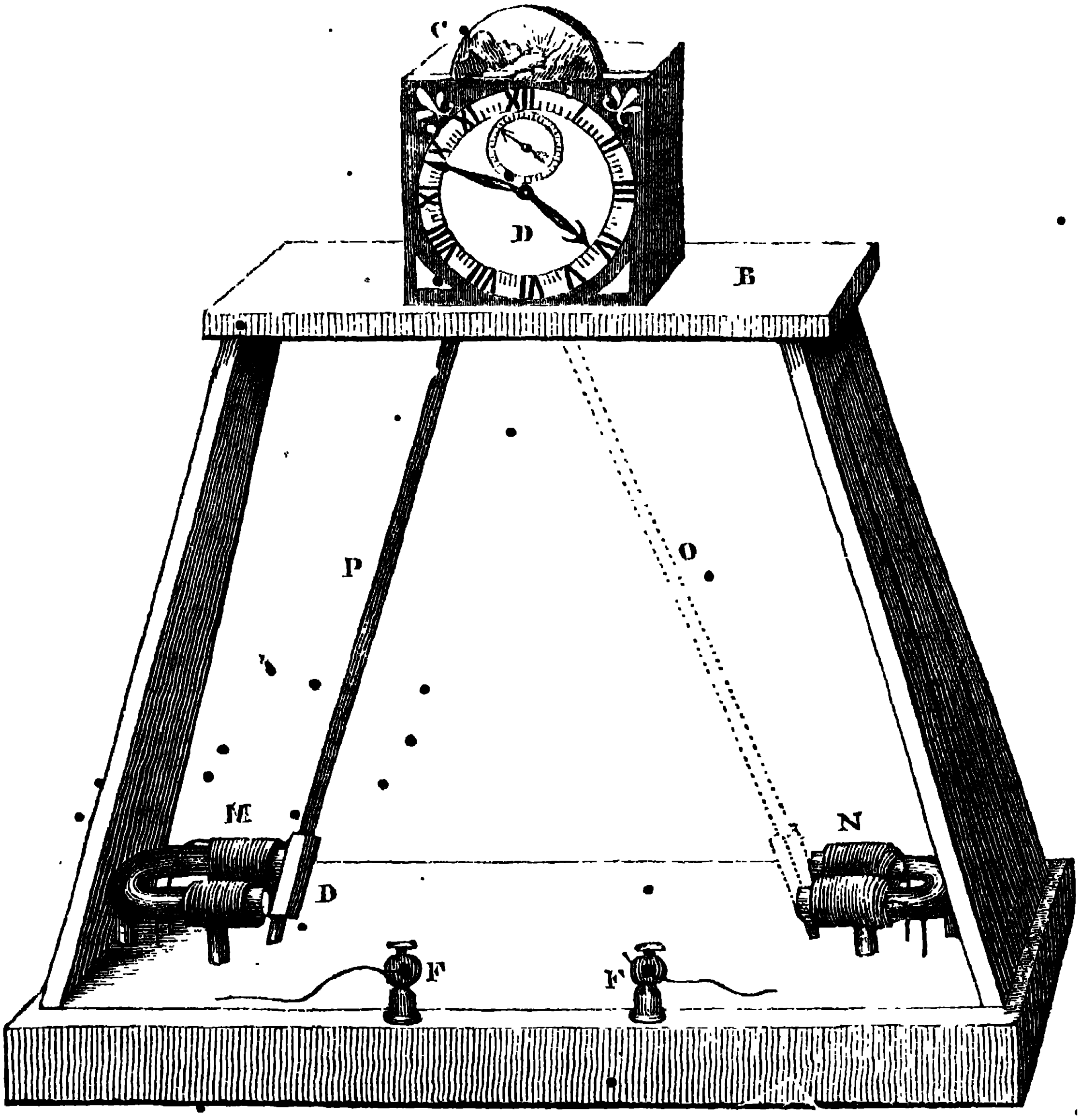
Some practice and a delicate hand are required to form an even plat with a number of these narrow strips, and to keep them disentangled and in their places without breaking them. Each plat is made with seven, nine, eleven, or thirteen slips of straw; it may therefore be supposed that some degree of nicety is required in its execution. This employment is most usually assigned to females, as being more particularly appropriate to their habits. The Italian plat is considered fine when fourteen or more knitted together do not exceed four inches in breadth. Leghorn plat has always been much esteemed in England, as being very superior to our home manufacture, and it has long formed an article of considerable importation, either as made up in the form of hats, or in the simple plat. During the late war the importation of this article was attended with so much expense and difficulty, as nearly to annihilate this branch of foreign commerce. The home manufacture was, in consequence, very much increased and encouraged; its improvement likewise became an object of importance, and many attempts were made to render all foreign supplies unnecessary.

Mr. Corston, an eminent manufacturer of straw hats, was among the first who took active measures to promote this desired result, and at the beginning of the present century he made strenuous exertions to obtain a successful imitation of the Leghorn plat in this country. In prosecuting his endeavours with persevering energy, he appears to have been actuated more by the disinterested feelings of the philanthropist than by the petty views of the tradesman, and to obtain an increase of healthy and profitable occupation for his countrywomen in the humbler walks of life was the ruling motive for his exertion. Taking an average of the ten years preceding 1804, he found that 78,000 Leghorn hats were imported annually into England, besides a quantity of plat, which, supposing five hats are made from one pound of plat, could be manufactured into two or three thousand more. From this, and other data, he calculated that if the foreign plat were superseded by that of English growth and manufacture, employment would at once be obtained for 5,000 young women and female children; and that 2,000 acres of very poor land, unfit for other purposes, might be brought into profitable cultivation. For the furtherance of his object he instituted a school at Fincham, in Norfolk. On a poor and sandy soil rye-grass seed was sown, in the proportion of two bushels per. acre. Each of these acres produced forty pieces of Leghorn plat of fifty-five yards in length, and employed for one week thirteen children to sort the straw, and eighty plat it.

Three years were spent by Mr. Corston in bringing this manufacture to perfection, before his efforts were crowned with success. It appears that he was then rewarded with their gold medal by the Society for the Encouragement of Arts, &c. His exertions did not, however, meet with that success which had been anticipated. For when peace at length restored to Europe free commercial intercourse, the demand for, and the supply of foreign hats became greater than ever.

(To be continued.)

Fig. 1.



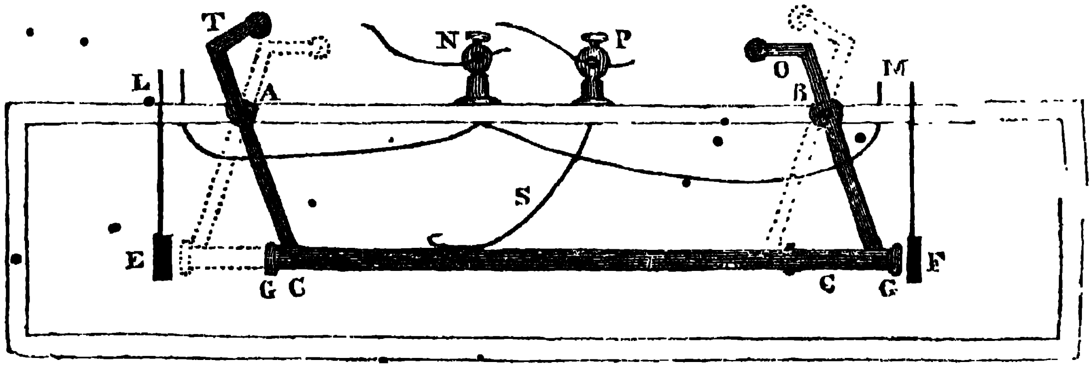


Fig. 2.

ELECTRO-MAGNETIC CLOCK.

ELECTRO-MAGNETIC CLOCK.

(To the Editor.)

SIR,—Ever wishing to promote the utility of your excellent Magazine, I beg leave to forward to you a description and figures relative to an Electro-Magnetic Clock; to insert which, in your valuable pages, if deemed worthy, will greatly oblige your humble servant, J. PARNELL.

Upper Clapton, Nov. 26th, 1841.

Fig. 1, represents the clock. D is the dial-plate, with a case C behind, which contains the wheel-work, fixed on a box B, in which the pendulum of the clock oscillates; we will suppose that one side of this box is removed, so as to expose to view its action; P represents a pendulum of such a length as to beat seconds; near the extremity of P are fixed two pieces of steel or iron, one on each side of it, or the bob may be of iron. On the lower case are two electro-magnets M N, between which the pendulum oscillates: the beginning and termination of each of the coils are connected with an apparatus in the stand, which will be explained hereafter; at F are two binding screws, for the purpose of making the connection with the galvanic battery. Between the poles of each electro-magnet projects a small brass trigger, (omitted in Fig. 1 to avoid confusion;) seen in Fig. 2 at O T, which moves on pivots A B, having small friction wheels at the ends of them; P and N are the two binding screws connected with the positive and negative poles of the battery respectively. The beginning and termination of each of the coils are seen at L M. Now the beginning of each coil is connected with the binding screw N, and P is connected by means of a spring S with the brass bar C C, to which are fixed on pivots the two triggers; at both ends of the bar C C are small plates G G, which rest alternately against the plates F and E, connected with the terminations of the coils as seen in the figure; so that when C C is in the position represented in the figure, the electricity will enter at P, pass along S and C to F, circulate along the coils at M, (Fig. 1,) and return to N; when in the position represented by the dotted lines, it will circulate along the coils of M (Fig. 1). Now if the pendulum be brought close to the magnet M it will push back the trigger, and thereby break the connection of the battery with M, but make a connection with H; the pendulum, therefore, will swing back of its own weight, and approach sufficiently near to H to be attracted by it; in touching H, it pushes back *its* trigger, and thereby breaks *its* connection: the pendulum, therefore, swings back towards M, where the same action takes place as took place at H; so that when the pendulum is once set in motion, it continues oscillating as long as there is a connection with the battery. This motion is communicated to the clock by means of a common escapement wheel, &c., which has 60 teeth, so that it performs a complete revolution once in a minute, since the pendulum beats seconds; this wheel is connected with the second hand, and by means of other wheel work to the minute and hour hands. The invention of this simple application of electro-magnetism to clocks is, I beg leave to state, original, but whether it will ever come into use remains to be proved.

[We have also received the following letter from the same gentleman, which we are very ready to insert, but cannot do so without at the same time making a remark or two respecting it. The letter refers to an experiment in page 218 of the present volume. In the first sentence below, our correspondent is certainly in error, in implying that any thing should be kept back, because it may have occurred to those who are already acquainted with the subject; our object is instruction to those who desire information, and in working out this object, we must not surmise that they know the matter already, else where shall a line of demarcation be drawn, and what precise amount of knowledge ought we to demand that our readers shall have previously acquired. In the succeeding part of the letter, he is no doubt quite correct in the explanation of the so-called "magnetic" spark, but it is evident, that our former correspondent intended to offer a simple and useful instrument, rather than to explain the *criticalities* of science, and after all, the only error it seems is using the word *produced* instead of *induced*, and this may possibly have been a printer's error. It is evident, however, that both correspondents have no desire but our benefit, therefore we thank them both, and have added these remarks, only because we are anxious and always have been, to nip in the bud any approach to angry discussion, particularly relative to the good-natured communications of correspondents; at the same time, we are bound to correct any and every error. We trust we may be allowed also to add, that we hope no scientific friend will withhold his contribution under the impression that others are as clever as himself. If he were to read the letters we received in a single week, such an impression would be effectually removed.—ED.]

(To the Editor.)

SIR,—The experiment which your correspondent W. W. mentions in the last part of your Magazine, I should imagine has struck the mind of every person who has for one moment considered the principle of a magneto-electrical machine; the mere fact that a spark can be elicited by this simple means, I myself proved many months ago. Again, he says that the "magnetic" spark is produced; now if he means to say that the spark which is produced is actually caused by the passage of the magnetic fluid, I beg leave to state, that I totally disagree with him on that point. I hold, and so I think most other persons do, that, forasmuch as electricity circulating along an insulated conductor around a bar of soft iron induces magnetism into that bar, therefore the converse of this is true, that when magnetism is induced (as in the case in question,) into the said bar, electricity is circulating along the insulated conductor: and, moreover, the fluid here circulating, whatever it may be, produces exactly the same effects as voltaic electricity. Nevertheless, Sir, far be it from me to pull down that which any correspondent may have kindly contributed to your Magazine; but allow me to add, that I write this letter, intending disrespect to no man; but merely to further, *if possible*, your meritorious exertions for the advancement of the "Magazine of Science."

J. PARNELL.

Clapton, Nov 13th, 1841

MONSOONS AND TRADE WINDS.

THOSE winds which blow in a certain direction for a time, and at certain stated seasons change, and blow for an equal space of time from the opposite point of the compass, are called monsoons. During the months of April, May, June, July, August and September, the wind blows from southward over the whole length of the Indian ocean, viz., between the parallels of 28° N. and 28° S. latitude, and between the eastern coast of Africa and the meridian which passes through the western part of Japan; but in the other months, October, November, December, January, February, and March, the winds in all the northern parts of the Indian ocean shift round, and blow directly contrary to the course they held in the former six months. For some days before and after the change, there are calms, variable winds, and tremendous storms with thunder, &c. Philosophers differ in their opinions respecting the cause of these periodical winds; but a more probable theory of the general trade winds is, that they are occasioned by the heat of the sun in the regions about the equator, where the air is heated to a greater degree, and consequently rarefied more than in the more northern parts of the globe. From this expansion of the air in these tropical regions, the denser air, in higher latitudes, rushes violently towards the equator from both sides of the globe. By this conflux of the denser air, without any other circumstances intervening, a direct northerly wind would be produced in the northern tropic, and a southern one in the other tropic; but as the earth's diurnal motion varies the direct influence of the sun over the surface of the earth, and as by that motion this influence is communicated from east to west, an easterly wind would be produced if this influence alone prevailed. On account of the co-operation of these two causes at the same time, the trade-winds blow naturally from the N.E. on the north, and from the S.E. on the south of the line, throughout the whole year; but as the sun approaches nearer the tropic of Cancer in our summer season, the point towards which these winds are directed will not be invariably the same, but they will incline more towards the north in that season, and more towards the south in our winter. The land and sea breezes in the tropical climates may be considered as partial interruptions of the general trade-winds; and the cause of these it is not very difficult to explain. From water being a better conductor of heat than earth, the water is always of a more even temperature. During the day, therefore, the land becomes considerably heated, the air rarefied, and consequently in the afternoon a breeze sets in from the sea, which is less heated at that time than the land. On the other hand, during the night, the earth loses its surplus heat, while the sea continues more even in its temperature; towards morning, therefore, a breeze regularly proceeds from the land towards the ocean, where the air is warmer, and consequently more rarefied, than on shore.

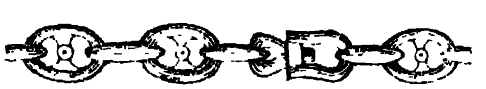
The cause of the monsoons is not so well understood as that of the general trade-winds; but what has been just remarked suggests, at least, a probable theory on the subject. It is well-known, that at the equator the changes of heat and cold are occasioned by the diurnal motion of the earth, and that the difference between the heat of the day and the night is almost all that is perceived in those tropical regions; whereas in the polar regions the great vicissitudes of heat and cold are occasioned by the annual motion of the globe, which produces the sensible changes of winter and summer; consequently, if the heat of the sun was the only cause of the variation of the winds, the changes, if any, that would be produced by those means in equatorial regions, ought to be diurnal only, but the changes about the pole should be experienced only once in six months. As the effects arising from the heat of the sun upon the air must be greater at the equator than at the poles, the changes of the wind arising from the expansion of the air by the sun's rays must be more steady in equatorial than in polar regions. The incontrovertible evidence of navigators proves this truth, that winds are more variable towards the poles, and more constant towards the equator. But in summer, the continual heat, even in high latitudes, comes to be sensibly felt, and produces changes on the wind, which are distinctly perceptible. In our own cold region, the effects of the sun on the wind are felt during the summer months; for while the weather in that season of the year is fine, the wind generally becomes stronger as the time of the day advances, and dies away towards the evening, and assumes that pleasing serenity so delightful to our feelings. Such are the diurnal changes of the wind in northern climates. The annual revolution of the sun produces still more sensible effects. The prevalence of the western winds during summer we may attribute to this cause, which is still more perceptible in France and Spain, because the continent of land to the eastward being heated more than the waters of the Atlantic ocean, the air is drawn, during that season, towards the east, and consequently produces a western wind. But these effects are much more perceptible in countries near the tropics than with us. For when the sun approaches the tropic of Cancer, the soil of Persia, Bengal, China, and the adjoining countries, becomes so much more heated than the sea to the southward of those countries, that the current of the general trade-wind is interrupted, so as to blow at that season from the south to the north, contrary to what it would do if no land was there. But as the high mountains of Africa, during all the year, are extremely cold, the low countries of India, to the eastward of it, become hotter than Africa in summer, and the air is naturally drawn thence to the eastward. From the same cause it follows that the trade-wind in the Indian ocean, from April till October, blows in a north-east direction, contrary to that of the general trade-wind in open seas, in the same latitude; but when the sun retires towards the tropic of Capricorn, these northern parts become cooler, and the general trade-wind assumes its natural direction.

Having given the most obvious causes of the periodical monsoons in the Indian seas, it is necessary to observe that no monsoon takes place to the southward of the equator, except in that part of the ocean adjoining to New Holland. There the same causes concur to produce a monsoon as in the northern tropic, and similar appearances take place. From October till April, the monsoon sets in from the N.W. to S.E. opposite to the general course of the trade-wind on the other side of the line; and here also the general trade-wind resumes its usual course during the other months, which constitute the winter season in these regions. It may not be improper to conclude this account of the tropical winds, by enumerating some of the principal inflections of the monsoons. Between the months of April and October the winds blow constantly from W.S.W. in all that part of the Indian ocean which lies between Madagascar and Cape Comorin, and in the contrary direction from October till April, with some small variation in different places; but in the Bay of Bengal these winds are neither so strong nor so constant as in the Indian ocean. It must also be remarked, that the S.W. winds in those seas are more southerly on the African side, and more westerly on the side of India; but these variations are not so great as to be repugnant to the general theory. The cause of this variation is, as was before intimated, that the mountainous lands of Africa are colder than the flatter regions of Arabia and India; consequently the wind naturally blows from these cold mountains, in the summer season, towards the warmer lands of Asia, which occasions those inflections of the wind to the eastward during the summer months. The peninsula of India lying so much farther to the south than the kingdoms of Arabia and Persia, adds greatly to this effect, because the wind naturally draws towards them, and produces that easterly variation of the monsoon which take place in this part of the ocean, while the sandy deserts of Arabia draw the winds more directly northward, near the African coast. A similar chain of reasoning will serve to explain any other inflections or variations that may occur in the perusal of books of travels &c.

MANUFACTURE OF CHAINS.

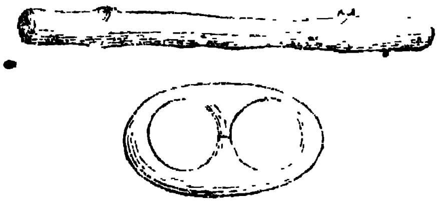
(Resumed from page 285, and concluded.)

In the substitution of iron for hemp in the manufacture of cables, the two great desiderata, durability and security, are largely secured in the use of the former material: the next object has been to unite with these, economy in the expense and lightness in the article. The amazing stress which a large ship riding at anchor in foul weather exerts upon the cable, can hardly be conceived by those who have never witnessed its effects. Next, therefore, to the necessity for the iron and the workmanship being such as should not give way, it was indispensable that the links should not draw together at the sides from great longitudinal stress. To secure this end, it has become common, in making the heaviest cables, to place within each link a stout bar to prevent lateral compression, in the manner represented by the annexed sketch of a portion of the chain of the Messrs. Acraman, of Bristol.

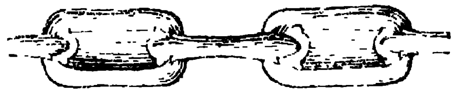


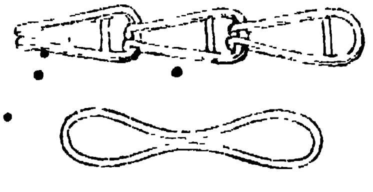
It has been contended by some persons, that any advantages supposed to be derived from stays or bars inserted in the direction of the shorter axis of the link are more than counterbalanced by concomitant inconveniences. In the first place, the ponderous chains used as cables are rendered so much heavier by this addition of metal, as to amount to a serious drawback on their acknowledged excellence in other respects: secondly, when the bars are made, as has been the case, with pointed ends, inserted by means of holes or mortices into the sides of the link, they are said to be liable during an extraordinary strain to be driven through or into the sides, and thus to split the iron: and, thirdly, that these bars distending the sides of an elliptical link, so as to prevent it from collapsing at all under any circumstances, the chain is on this account, rendered rather less than more effective as to its ultimate degree of security. In 1820, a cause of infringement of patent, arising out of improvements on the above contrivance, was tried at the King's Bench, viz. Brunton *versus* Hawks and Co. The case alleged that the defendants were manufacturing cable chains on the principle of those for which the plaintiff had, in 1813, obtained a patent; an injunction of restraint was therefore prayed for. The solicitor-general, for the defendants, contended that his clients had not copied their link from that described in the plaintiff's drawing, but had merely used an oval link with a stay in it, and which had not only been before patented to Captain Brown, but was, as he should prove, a very old invention, and therefore the plaintiff could not have any exclusive right in it. A number of witnesses were examined to prove that links with bars across had been made before either the plaintiff or Captain Brown took out patents for them; and two old sailors deposed that, so long as thirty or forty years ago they had worked up old links with bars similar to those before them in court. There did not appear, however, any good evidence to prove that any stay had been manufactured before Brunton's on the same principle, namely, instead of being smallest at the ends and thick in the middle, was spread out at the ends so as to overlap the sides of the link; an arrangement, in the opinion of Mr. Bramah, entirely new, and far superior to any stay that had been previously introduced. Dr. Olinthus Gregory, of the Royal Military Academy, Woolwich, was a material witness on this trial, and the substance of his testimony is interesting on the point at issue. He stated, that one peculiar merit of the plaintiff's chain cable was, that there was a stay placed across each link, to keep the sides of the link from collapsing; that this stay was made broad at each end, to support a considerable portion of the sides of the link; and that the stay was made to lap nearly half around that portion of the link, so that it was kept from falling out by its own form, without the sides of the link being at all weakened by any indentation into its substance, as was the case with stays formerly put into the links of chains: another peculiar merit of the plaintiff's improvement on chain cables was, that he made those parts of the link that were between the stay and the next adjoining link in a straight line as near as may be, and the whole link and stay being in the same plane, that is, without having any twist as Captain Brown's links had, by which arrangement, every part of the link was subjected to an equal strain, and was the strongest possible form into which iron could be put for the purposes of a chain cable. The witness stated that he had made experiments on two sorts of chains, one with the link as described in the plaintiff's specification, and the other chain with the common elliptic links without a stay: that he formed one chain of two by uniting their ends, and subjected them to a great strain, which changed the form of each elliptic link, so as to weaken them essentially; and at length broke that chain without in the least degree injuring the plaintiff's links. The witness afterwards tried, in the same manner, a piece of chain with elliptical links, having a stay in each link, which bore a much greater strain than the other, but finally broke, without the patent chain suffering any injury whatever.

Captain Brown's link is twisted, so as to admit of a certain degree of extension in case of very violent stress; but in the opinion of Mr. Brunel, civil engineer, the weight of a cable chain is more than equivalent to any elasticity which can be given to a link by twisting, in resisting the sudden jerks which are generally occasioned by a rough sea; elasticity cannot be given without weakening the iron, as every change of figure of the iron produced by a strain, tends to injure the fibre of the iron and rupture it. It was with the inventions of Captain Brown and Mr. Brunton, and the evidence and result of the trial just mentioned before them that in October 1820, William and Daniel Acraman two Bristol iron-masters, obtained their patent for "certain improvements in the processes of forming the materials for and manufacturing chains and chain cables." Besides the tendency of the pointed stays to drive into the side of the link, as stated by Dr. Gregory on the trial alluded to, another witness on the other hand took occasion to state that he had seen portions of that part of Brunton's stay which clips or overlaps the link broken off. To obviate both these inconveniences, and at the same time to steer clear of the property of others, the Bristol patentees devised a link on an entirely new construction. They formed cylindrical bars of iron, with projections or swells, so placed on the sides at given distances, that when the bar was formed or turned into a link, these projections would fall exactly opposite each other, and thus by their contact form a most effectual stay, perfectly immoveable by pressure or strain. In links of this description it is obvious there are no thin edges or angles liable to be chipped off or worn away. In other cases, as in the section of chain first represented, the projections or swells being left somewhat lower, are both indented or countersunk so as to form recesses for the reception of a stay, which is introduced, and closed in by pressure, on the bar being turned into a link; the cylindrical part of the chain being preserved, and retaining more strength and substance in this than in any other part of the chain. The extremities of each bar are scarfed, so as to fold over each other a sufficient length, and by this means give to that part of the link which is shut or welded, additional strength.



From a circular published a few years ago by the celebrated anchorsmiths just named, and exhibiting some scores of testimonies in favor of iron cables, the following particulars are derived:—In comparing these cables with the hempen ones, the first and strongest plea of advantage is their durability, which equals that of the ship itself; whereas our West India traders generally require a renewal of the latter after a second voyage. Another economical object is presented by the room, which is ordinarily taken up by the rope, being open for a greater stowage of cargo; as the chain may be so placed as to occupy no otherwise useful space, and may be left on deck without injury by exposure, if necessary. At quays, parts may be applied for mooring; or the cable may lie in the hold, to assist to ballast the vessel when unladen. The facility of working iron cables has been experienced, as fewer hands are employed; and it has been ascertained, that with them vessels can get under weigh by a saving of at least one-third of the time otherwise required. A more positive proof of their superiority may be adduced from the assurances of captains, who confess they have no use for their hemp cable, and which may be laid aside by having a *second* bower iron cable; as the ships in the ports of Bristol, London, and Liverpool, bear evidence. On rocky ground the anchorage is effected without injury to the chain, where hempen cables must be cut to pieces, and endanger the vessel. A most important advantage results from the curve, which the chain cables retain to a very great degree, as it strengthens the hold of the anchor by drawing it into the ground; the buoyancy and contraction of the rope, on the contrary, bearing a direct line from the ship, tends to loosen and unfix it: and as nearly one half of the chain lies on the ground, when any scope is out, it yields to the tossing motion of the vessel, and this to a degree equal to any elasticity which can safely exist in hemp cables. We may, however, observe that no elasticity such as is here spoken of can be acquired without the loss of strength to the material, as the fibres or particles in iron or hemp must be extended, and consequently weakened or broken, to produce it. Into this chain cable a certain number of swivels are introduced, at proportionate lengths, to facilitate the working of it; and a shackle is placed in each distance of ten or twelve fathoms, the bolt of which is fastened by a pin of composition metal to prevent the corrosion of rust; by this contrivance the chain is shortened or separated according to circumstances. A large shackle is also fixed at one end to be joined to the anchor; and when required, a mooring ring is attached to the end of forty fathoms to moor with two anchors in harbour. The necessity of handling the chain is partly superseded by the use of small hand-hooks; and to prevent the chain from wearing the wood-work of the vessel, the hawse-hole is cased with a wrought or cast iron pipe, and fitted outside with three circular rollers working in a frame. It has, in the estimation of sailors, a good appearance. In 1822, Mr. Sowerby, of Bishopwearmouth, obtained a patent for a cable chain, with a link having a very broad stay or block of cast iron, through which, and the sides of the link, a cross bar of malleable iron was passed and welded. And for the purpose of preventing the links from entangling, there are small projecting parts or protuberances on the inner quarters opposite to each other. The cut represents the form of Mr. Sowerby's chain. The next is a chain constructed by Mr. Gladstone, of Liverpool. The links are first formed in the manner indicated by the second cut, being also welded at the place where the sides are in contact.





The link is then bent, and the two circular ends brought against each other; so that when the links are roved together, and a cross bar inserted, the chain appears as in the figure.

* * *

IMPROVED APPARATUS FOR THE HOT BLAST.

Mr. Philips, of Brooklyn, New York, has invented an improved method of heating the air, to supply the blast in smelting furnaces, in which mineral coal is used, and in which there is an air-heating apparatus at the tunnel head. The following is the description of this improvement, given by the inventor in his specification:—For the purpose of economising fuel, it is of considerable importance to be able to use the waste heat for supplying the blast to the smelting furnace, and this has been done in numerous instances, and under various modifications of the apparatus employed. It has been found, however, that in all cases the air so heated is subjected to great variation in its temperature, and that from causes incident to the employment of such furnaces when dependence is had upon the waste heat alone to accomplish the intended purpose. Whatever produces a diminution of heat in the interior of the furnace must produce a corresponding effect in the air-heating apparatus, and that at a time when it is most desirable to keep up or increase the temperature of the hot blast, in order the more rapidly to restore the necessary temperature in the furnace. One of the most general causes of the temporary diminution of heat in the furnace is the introduction of the charges of coal, ore, and flux. The quantity of gas emitted from the fuel also varies considerably in different stages of its combustion, and with it, of course, the quantity of flame in the heating apparatus; other sources of such variations of heat are well known to those conversant with the use of smelting-furnaces. My improvement is intended to, and does effectually, obviate this difficulty, and that in the following manner:—On the sides of, or otherwise close to, the heating apparatus on the tunnel head, I place one, two, or more, small furnaces, for the express purpose of heating a portion of air which is to pass from them into the heating oven, and to commingle with that arising through the chimney of the smelting-furnace. To these auxiliary furnaces I make close fitting doors, in order that no air shall pass into them, excepting that which is formed to pass through the burning fuel which they are to contain. Into the ash-pit of these auxiliary furnaces I introduce a pipe, through which air, either hot or cold, may be blown from any suitable part of the blowing apparatus, which, by passing through the ignited fuel, and thence directly into the heating oven, may be made to communicate a very high degree of heat to the pipes contained therein; I of course regulate the supply of air to be blown into the heating oven, and to pass from the blowing apparatus into the auxiliary furnaces, by means of cocks, valves, or dampers, applied in the ordinary way, which devices are well known to all machinists. When it is not requisite to employ the heat from the auxiliary furnaces, by closing the valves in the passages leading into, and from them, the contained fuel will merely remain ignited, scarcely undergoing any combustion until urged by the blast.

STRAW PLAT.

(Resumed from page 296.)

MANY attempts have been made to induce the English ladies to wear straw hats of home production alone. But causes, independent of the influence of fashion, have hitherto prevented the exclusion of those of foreign manufacture. It is said that the quality of the foreign straw is superior to that of the English, the warm sun and more genial climate of Italy producing a material which cannot be equalled here. The Leghorn straw is more slender, and may therefore be employed entire in the production of the very fine articles, on which account the plat is rendered more even, pliable, and durable than that of equal fineness made of split straw; while it has the farther advantage that the spiral coil of Leghorn plat admits of its being joined by knitting the adjacent edges together, thus producing an imperceptible juncture and forming all the plats into one uniform whole. The nature of the English plat will not allow of this, and it is necessarily over-lapped and sewed together in an unpleasing alternation of ridges and depressions, to effect which a considerably greater quantity of plat is likewise required.

To protect our domestic manufacture, and to encourage the importation of the Italian straw, a duty of £3. 8s. to £6. 16s. per dozen, according to their size, is levied on the importation of hats made of this material, a lighter one of 17s. per pound upon plat not made up, and merely an ad valorem duty of 10 per cent. on straw not platted. Such, however, is the cheapness of labour upon the Continent, in comparison with its rate in England, that the best Hertfordshire straw has actually been sent to Switzerland; platted in that country, and returned to England, where, notwithstanding the import duty of 17s. per pound, it can be sold at twenty-five per cent. cheaper than plat made at home.

In consequence of this difference of duty on the wrought and unwrought materials, a straw manufacturer a few years since imported a considerable quantity of prepared straw from Leghorn, and not succeeding in the platting, placed it in the hands of Mr. Parry, who first made himself a proficient in the Leghorn method of platting, and then taught it to other persons with so much success, that in a short time he had above seventy persons, women and children, employed in this manufacture. On disclosing the particulars of the mode employed, he received an honorary reward from the Society for the Encouragement of Arts, &c., which society has, at various times, offered premiums for improvements in the home production and manufacture of straw plat, "influenced by the desire of thereby obtaining employment for the poor in the agricultural districts, by contributing to the revival and improvement of a manufacture at once healthful and domestic, and particularly valuable as accustoming children to habits of industry, without the imposition of any hurtful degree of bodily labour."

At nearly the same time another candidate appeared claiming a reward connected with this subject, and which revived the desire of rivalling the Italians in their straw produce as well as in its manufacture. Miss Woodhouse, the daughter of a farmer, residing at Weathersfield in Connecticut, sent to England a bonnet of very fine materials and manufacture, and which, on being submitted to the inspection of the principal dealers in such articles, was declared to be superior even to Leghorn in the fineness of the material and the beauty of its color. It was manufactured from a species of grass growing spontaneously in that part of the United States, and popularly known by the name of tickle-moth. This grass is found abundantly in most of the meadow land, but more commonly in fields that have not been highly manured. Specimens and seeds of this grass were obtained in the hope of promoting its cultivation in England. But little of the seed, however, could be procured, as it is never sown in America, but springs up luxuriantly, and is cut from the time of its flowering until the seed is not quite matured. On being sown in this country, it germinated very successfully, both under cover and in the open air.

In the mean time many experiments were made by Mr. Cobbett and others on our English grasses, and Leghorn plat of a most excellent quality was produced. The list of available grasses was continually increased by those persons who from time to time made experiments on the subject, and presented specimens of the result of their labours. A numerous class of grasses, like the common annual kinds of corn, have but few leaves; these gradually decay as the seed-stalks advance towards perfection, and wither, or fall off entirely, when the seeds are at maturity. The grasses which are applicable to the straw-plat manufacture are found in this class. Among these, the grasses which are proved to be the best suited to the purpose approach nearest in point of color to the fresh pale green of wheat: for, in general, as the hue recedes from the yellow, and the blue tint predominates, the deeper and deader yellow does the straw become when dried. Other points, however, are to be considered as well as the color, and these are not dependent alone on the particular species of grass. Mr. Parry found that the straw of grain grown upon clayey soils is liable to become spotted or otherwise discolored, and apparently takes up a larger proportion of iron than usual, whereby it is rendered unfit to be used for the better kind of plat. When raised upon sandy soils, it in like manner seems to take up an undue proportion of silex, or flint earth, and thus becomes harsh and too brittle for fine platting; but when grown upon chalky soils, as well as being of a superior color, it possesses the pliancy requisite for the best plat. The reputation which the Dunstable hats have so long enjoyed is attributed to this peculiarity arising from soil. The manner of preparing the English grasses, as recommended by Mr. Cobbett, very nearly resembles the Italian method. The grass is cut as soon as it comes into bloom, it is then tied up in small sheaves, put into a shallow tub, and covered with boiling water. It remains in this situation during ten minutes, on being taken out it is spread thinly on soft grass for a week, being turned daily during that time. The only part used for platting is that portion of the stalk which is between the upper knot and the seed-branches. It is, however, found necessary in England to cut and bleach the whole plant, because if this part were taken off while green, it would wither away; but when the preparation is finished, this as being the only useful part is taken, and the rest rejected. The grass used by Miss Woodhouse did not require this precaution. In her process the upper part was taken off previously to scalding and drying, which operations it underwent in alternations, until the leaves which sheath the stem came off; it was then moistened in a solution of pearlash and soap, and in order to whiten it was subjected to the fumes of sulphur. In consequence of the attention of agriculturists being called to this subject, many inducements were held out to further the promotion of so desirable an object. The Highland Society offered several premiums in 1825 and 1826, for encouraging the home manufacture in imitation of Leghorn plat. Several candidates appeared for the reward. Among these Messrs. Muir, of Greenock, gave a detailed account of their manner of cultivating and preparing the straw, which is very similar to that already described. After various experiments, however, they were induced to confine themselves wholly to the use of rye-straw, dwarfed by being grown on poor land in the Orkneys, and not suffered to attain to sufficient maturity for the production of good seed.

Mr. Cobbett has observed that the circumstance which recommended the inquiry especially to his attention, was the great advantage that this manufacture possesses in not requiring the collecting together of a number of people. "All may be performed by a single pair of hands—no power of machinery is wanted—no other capital than can be commanded by any labourer's wife in the kingdom. The boiling of a pot of water is the sole expense necessary to furnish her and her children with work for a part of the winter, and the only engines requisite are their fingers." Notwithstanding, however, all these well-meant exertions of the several individuals, the same causes long operated in retaining Leghorn hats among our articles of commerce, and their importation continued in an increasing ratio, 230,000 having been imported in 1825, and 381,000 in 1828. In the following year the quantity was reduced more than one-half, owing principally to a change of fashion; and in 1832 the number brought for use from abroad was only 60,830. The straw selected for the purpose of making hats and bonnets in this country is every year improving in quality. In different specimens which were exhibited in 1825, those prepared from spring wheat were pronounced to be decidedly the best, and very superior to any preceding specimens. But grasses are still considered to be very useful materials. By the careful cultivation of those which are more peculiarly adapted to this purpose, a constantly improving material is being produced while greater skill is displayed in the manner of its preparation. Straw may not be obtained sufficiently slender to produce a very fine plat without being split, which gives to the English hats nearly the same durability as the Italian.

Hats are likewise fabricated of chips or thin slips of wood. This manufacture preceded that of straw plat in England, though it would seem to be less obvious and natural. The trees which are most appropriate for the purpose are the lime, the poplar, the willow, and some others, the wood of which is white without knots. While the wood is yet green it is divided into very fine chips; this operation is easily performed by means of a very simple instrument, a plane with two irons. The first of these is provided with several teeth, the width of which is proportionate to the required fineness of the chips; the second iron, which follows the first, has a common plain chisel-edge. On this plane being passed over the wood, it is evident that the shavings will be divided longitudinally into as many slips, and one more, as there are teeth in the first iron. That the teeth may be made to repass always over the same spot, the plane is pushed between two guides, by which means it is kept steady in one direction. Several machines have from time to time been invented for dividing these chips, but this double iron plane is the simplest, and perfectly answers the purpose for which it was intended.

(To be continued.)

MR. PATRICK'S RULES FOR JUDGING OF THE WEATHER BY THE BAROMETER.

These are esteemed the best of any general rules hitherto made.—1. The rising of the mercury presages, in general, fair weather; and its falling, foul weather, as rain, snow, high winds, and storms. 2. In very hot weather, the falling of the mercury indicates thunder. 3. In winter, the rising presages frost: and in frosty weather, if the mercury falls three or four divisions, there will certainly follow a thaw. But in a continued frost, if the mercury rises it will certainly snow. 4. When foul weather happens soon after the falling of the mercury, expect but little of it; and on the contrary, expect but little fair weather when it proves fair shortly after the mercury has risen. 5. In foul weather, when the mercury rises much and high, and so continues for two or three days before the foul weather is quite over, then expect a continuance of fair weather to follow. 6. In fair weather, when the mercury falls much and low, and thus continues for two or three days before the rain comes, then expect a great deal of wet, and probably high winds. 7. The unsettled motion of the mercury denotes uncertain and changeable weather. 8. You are not so strictly to observe the words engraven on the plates, as the mercury's rising and falling; though in general it will agree with them. For if it stands at much rain, and then rises up to changeable, it presages fair weather; though not to continue so long as if the mercury had risen higher. And so, on the contrary, if the mercury stood at fair, and falls to changeable, it presages foul weather; though not so much of it as if it had sunk lower.

Upon these rules of Mr. Patrick the following remarks are made by Mr. Rowning: That it is not so much the absolute height of the mercury in the tube that indicates the weather, as its motion up and down: wherefore, to pass a right judgment of what weather is to be expected, we ought to know whether the mercury is actually rising or falling; to which end the following rules are of use:—

1. If the surface of mercury is convex, standing higher in the middle of the tube than at the sides, it is a sign that the mercury is then rising. 2. But if the surface be concave, or hollow in the middle, it is then sinking. And, 3. If it be plain, or rather a very little convex, the mercury is stationary: for mercury being put into a glass tube, especially a small one, naturally has its surface a little convex, because the particles of mercury attract one another more forcibly than they are attracted by glass. Further, 4. If the glass be small, shake the tube; then if the air be grown heavier, the mercury will rise about half a tenth of an inch higher than it stood before; but if it be grown lighter, it will sink as much. And, it may be added, in the wheel or circular barometer, tap the instrument gently with the finger, and the index will visibly start forwards or backwards, according to the tendency to rise or fall at that time. This proceeds from the mercury's sticking to the sides of the tube, which prevents the free motion of it till it be disengaged by the shock: and, therefore, when an observation is to be made with such a tube, it ought to be first shaken; for sometimes the mercury will not vary of its own accord, till the weather is present which it ought to have indicated.

MEMORANDA.

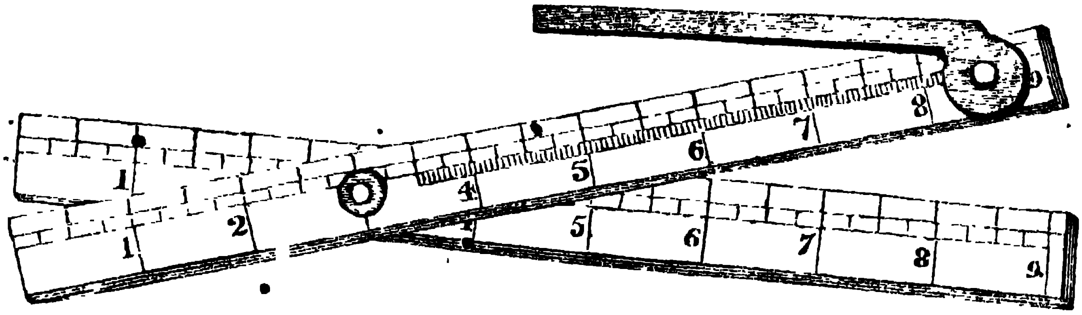
New Method of Churning.—The churn is firmly placed in the body of a cart, and by the simple application of toothed wheels to the axle-tree, the motion of the cartwheels, when the horse walks forward, is communicated by means of a crank to the churn. From the greater rapidity of the strokes thus effected, the butter is more quickly produced than when the hand is the motive power; and where the churn is not a large one, a donkey and small cart will answer the purpose sufficiently well. Mr. Osborne, Dalscone, in whose dairy this plan of churning is pursued, employs a small pony to perform the work, which is driven along the high road until the butter is produced; and an odd-looking affair it certainly appears when it strikes the vision of any passing traveller.—*Dumfries Courier.*

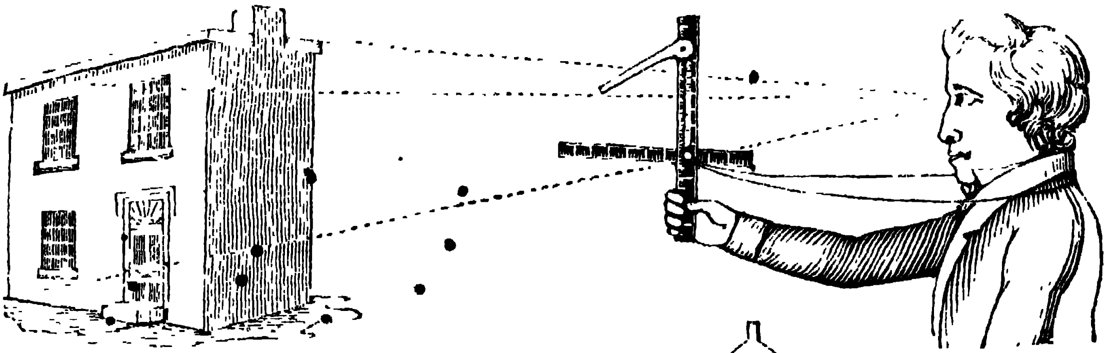
Light from Stale Fish.—Dr. Hulme has established that the quantity of light emitted by dead animal substances, is not in proportion to the degree of putrefaction in them, as is commonly supposed; but, on the contrary, the greater the putrescence, the less light is evolved. It would seem, that this element, endowed with pre-eminent elasticity, is the first to escape from the condensed state of combination, in which it had been imprisoned by the powers of life; and it is followed, after some time, by the relatively less elastic gases, the evolution of which contributes to putrefaction.—*Popular Errors.*

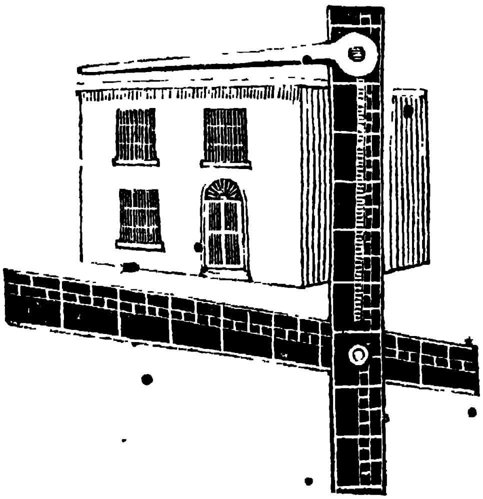
The Wool of the Lama.—A gentleman of the name of Woolaston, who has resided for some years among the mountains of Thibet, has lately discovered a species of the Lama, the color of which is perfectly black, and its hair as soft as silk. As a staple commodity, he states that it does not possess the properties of wool, it being much more fine than is the latter material; but it would admirably well suit the fine shawl trade, as it is carried on in the manufactories of Glasgow and Paisley. The hairs run upon an average twelve inches in length, and are of a jet black color, so that they do not require dyeing to entertain a darker shade. A larger quantity of twist, which has been turned in the hills, has already been bought up by the French merchants on speculation, and sent to France, where it has realized as much as from 12*s.* 6*d.* to 14*s.* per pound, while the raw unspun material has met a ready sale at 2*s.* 6*d.* to 3*s.* per pound. The black Cashmere shawls have always fetched higher prices than any others of a similar description in the market; and it is not at all improbable, but that the beautiful silky hair of the "Alpaca," as it is called, is used largely by the Cashmere weavers in their manufacture of the latter very valuable as well as profitable article of commerce.

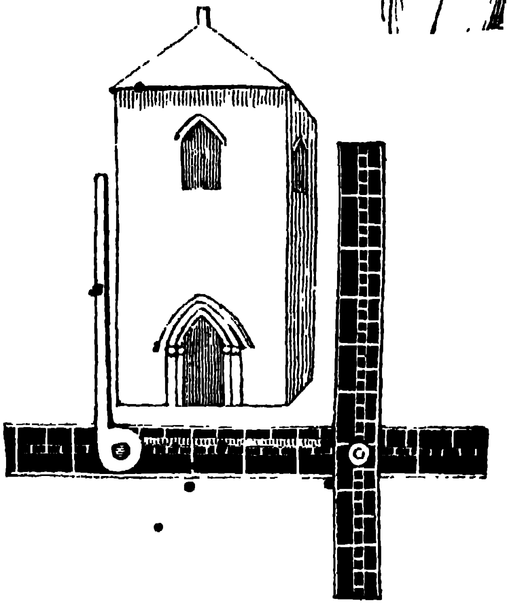
Fresco Painting.—The following substitute for fresco painting has been suggested in the decoration of the New Houses of Parliament, which, it is contended, will have an equally beautiful effect and be quite as durable. "The wall is first covered with Roman cement, commonly called stucco; after this is dry, it must receive three or four coats of a mixture of fat linseed oil boiled with gum, similar to varnish—in fact, it may be called varnish, only observing that it will not crack. This penetrates the cement, and keeps it from what is termed sweating. Then cover with the ground for the picture, preparing the color with half turpentine. For the picture itself, have your colors ground in oil and work them in turpentine, and it will have the same effect as fresco painting. It requires to be finished expeditiously, as the colors set fast. This sort of painting, I should say, would answer well: 1st. Because it will dry hard. 2nd. It will retain its color. 3rd. It is equal to fresco in beauty and appearance. 4th. After preparing the walls, the rooms may be used for business, and the artists continue their labours at such times as are most convenient, as there is but little or no dirt.—*Athenæum.*

Fig. 1.









3.

WILCOX'S PERSPECTOGRAPH.

(To the Editor.)

Sir.—I have endeavoured to perform my promise of giving you the drawing, and I hope an intelligible description, of a very useful instrument, one much approved of by all I have shown it to, who understand drawing; it may be made at a cost of about 5s. If you think it worth a place in your Magazine, make any alteration you think proper in the language; as, doubtless, you will find some parts that require amendment—my object has been to give such a description as to enable any person to make it.

JAMES WILCOX.

[We give the description entire, as written—ED.]

WILCOX'S PERSPECTOGRAPH.

An instrument of perfect simplicity; it requires neither stand to hold it, nor eye-hole to look through—merely suspending it to the neck insures its return to the same position, and when not wanted to be consulted, hangs by its string, without the least possible inconvenience; even the most practised in sketching may derive assistance from it, as it will determine the vanishing point for them in an instant, and measure unerringly all the proportions.

With this instrument, any person may draw buildings correctly in perspective; it is equally applicable to landscape, and is also of great use in copying pictures.

No. 1, is a view of the perspectograph, partly opened to show it more completely; it is made of two rules of brass, 9 inches long, and about $\frac{3}{4}$ inch wide, one of which has a stop, to allow an arm to slide in it,—they are screwed together at 3 inches from one end, which screw has its head formed into a loop or eye, by which it is suspended to the neck by a string, when in use.

No. 2, represents the manner of using it; the person being supposed to have set it to the form of the outline of a building, and in No. 3, to have laid it down on the paper, and ruled off by its inner edges the form of the house.

No. 4, another object being seen through it, and transferred to the paper.

It has a silk cord with a hook at each end: this cord is the greater part of its length double, and tied into knots about an inch apart; one end is hooked into the eye of the instrument, the other put round the neck, and hooked into such of the loops in the string as required.

The rules to be observed in sketching, are:—1st. The paper and the instrument must be of the same length, the height is of no consequence. 2nd. Having determined on the quantity and base line of the subject, put the string round the neck, hold the instrument level across the face, at such a distance from the eye, that its two ends just reached to the extent you wish to make the sketch; then put the hook into that loop that will retain it at that distance, particularly noticing two objects then at its ends, to be guides for all future reference. 3rd. Observe under every circumstance of using it, it must be held square to the subject, or its result will be deceptive.

Manner of using it.—When thus held up to the extent of the string, the position of every object in the landscape may be correctly mapped down by its divisions and figures; now open it to a right angle, keeping the base to the position first determined on, and the perpendicular side gives the correct height of all the objects.

Drawing Buildings.—While the perpendicular marks the upright, the base of the angle may be bent to the inclination of the bottom of the building, and the sliding arm to the top; being thus made to fit the outline, unhook, lay it on the paper, and the pencil being run along its inner edge, will give a correct outline in true perspective and proportion; by repeating this, all the different ranges of heights are as easily obtained, and the distances of pillars, windows, doors, &c., being shown by the figures. By reversing the ends, it becomes a foot rule, the figures being marked each way from the centre, and is then applicable to a larger paper; if opened to the corresponding lines at the back, a right angle is found, and a T square is produced.

ON THE MANAGEMENT OF BULBS.

Bulbs closely resemble buds in their structure, as well as in their functions, and differ chiefly in being under-ground, and of course out of light; while buds are not usually under-ground, and are consequently exposed more or less to light. Some bulbs are of close texture, as those of the tulip and snowdrop, while others are more open, as those of the white and the orange lilies, thence termed scaly bulbs. Bulbs may be classed, first, under *hardy*, requiring no shelter; secondly, as *half-hardy*, requiring some protection from cold and wet, without any artificial heat; and, thirdly, as *tender*, requiring more or less artificial heat. It is the cultivation of the first sort that we are about to describe. These will endure all weathers without any artificial heat or protection, and may be easily managed by observing the following directions:—

Soil and Seed Sowing.—The soil most adapted to the growth of bulbous roots, in general, is that of a sandy loam, where there is no stagnation of moisture below. Many sorts of these roots are not, however, very difficult in this respect, provided there be not an over-proportion of moisture. The ground for them should be prepared by digging it to the depth of from six to eight or ten inches or more, reducing it well in the operation. After this has been done, it should remain a week or ten days before the bulbs are put in, to become perfectly settled. Seed should be carefully saved from the best and most curious flowers, and when fully ripened, after having been hardened a little in the sun, should be sown in boxes of light rich earth, setting them in a sheltered sunny situation, but not under cover. This is usually done about the latter end of August or the beginning of the following month; large sorts being covered to the depth of nearly an inch, and smaller sorts half an inch. A little water should be occasionally given when the season is dry, to keep the soil moist, but not wet. The seeds may be protected till they come up by a little covering of some kind of strawy material. Other sowings may be made in March, or the following month, the boxes being brought into southern exposures, when there is only the morning sun towards May.

After Culture of Seedlings.—The young seedling plants should be protected in severe frosty weather, and when there is much rain, by means of mats and hoops, and a reed hurdle, or other contrivance, to break off the north-east winds. The young plants should likewise be kept properly thinned out, and perfectly free from weeds. When the stems decay, a little mould should be put upon them, to the thickness of half an inch. In the following summer when the leaves decay, as about August, they should be planted out into nursery-beds, at the distance of two or three inches, according to the kinds. Some sorts require to be removed from these into other nursery beds as soon as their tops decline, and set at six inches distance; or it is probably a better practice to thin them out to this distance in the first beds. After this they are to be managed as blowing plants. These sorts of roots blow at different lengths of time, after being raised, some in the first, some in the following year, and others not till several years afterwards. In all such plants a store of prepared pulp is laid up in the bulb each season, for producing the stems or flowers the succeeding season. It is clear then, that the more pulp there is stored up, or, in other words, the larger and plumper the bulbs are produced, the stronger and finer will the stems and flowers afterwards grow. Now as flowering and fruiting exhaust the pulp, let every flower in the seedling be pinched off in the bud, if they offer to blow, while the leaves must be left on the stem to prepare pulp for the root store, and make larger flower-buds in the centre for after blowing. In this way finer and larger bulbs can be produced than in any other way. It injures many bulbs, however, to break the flower stem, as would be the case, for instance, with respect to tulips.

Propagation by Stem Bulbs.—Some species, such as the tiger lily, produce on the sides of the top parts of their stems, at the inner base of the leaves, small dark colored bulbs, or buds, if they may be termed so, from which young plants may be raised. The stem bulbs should be taken off in August, and after being dried for a few days in the sun ought to be planted out in rows in the same manner as the young offsets from the root bulbs.

Improvement of Bulbs by Drying.—It is important to notice here the periodical activity and rest of plants, it being necessary for their health that they should have intervals of repose succeeding to activity, no less than sleep is needful to animals. In various processes of artificial management, the perfecting or extending this period of repose is found to be productive of very marked effects. By putting plants in a state of repose sooner than natural, they can be brought again into active growth sooner than their accustomed seasons; and by making it more complete than it can be made in a state of nature, the plants may be made to awake with greater vigour. With respect to bulbs, their period of repose commences, as in other plants, with the withering of the leaves; and as complete repose cannot be induced when the stimulus of moisture is present, it becomes necessary to take the bulbs out of the ground. As soon then as the choice sorts of bulbous flowers are past blowing, and the leaves beginning to die off, the bulbs should be taken out of the ground, choosing dry weather for this purpose; and they should be gradually and thoroughly dried by spreading them out and turning them, to prevent the appearance of mouldiness or canker. It is also important to cut off the flower stems just before flowering, to place these in water, and blow them there, allowing the leaves, as already explained in the cultivation of seedlings, to remain for the purpose of nourishing the bulb. But it is said that the bulb will be apt to canker and rot, if the flower stem be cut down after blowing, while it is still fresh, and before it dies down. There is another principle, which is usually overlooked by practical writers and practical men, for inducing a complete state of rest in the dug-up bulbs; and this is the influence of light. Bulbs, like all underground vegetable productions, dislike the light, and hence when bulbs are planted too shallow, they do not blow so finely as when deeper in the ground. Hence it is fairly inferred that light has, to speak physiologically, rather a sedative than a stimulant effect on bulbs; consequently, by placing the dug-up bulbs in the light, and not shutting them up in boxes and baskets, as most florists recommend, must induce a more complete state of repose. Besides, by carrying off the superfluous water from the stored-up pulp, it tends to enrich its nutritive properties, and this also is best effected in the light, which promotes evaporation as well as decomposition. The natural period of repose for most bulbs is six weeks, or two months, but many sorts may be kept out of the ground several months, and some sorts admit of being kept out of the ground from the time the flowers and leaves decay till the following spring, as is often practised, to obtain a longer succession of bloom in the flowers. Bulbs of the coated or laminated kinds, such as lilies, should not be kept out of the soil longer than six or eight weeks, the summer flowering sorts being set at separate periods in the autumn, and in the beginning of the year, before the latter end of February, so as to produce a succession of flowers. With others of a more delicate nature, this method is also common, but they should have a dry sandy soil, in order to stand the winter without rotting, where there happens to be much wet, succeeded by severe frosts. When bulbs have remained in the ground longer than the proper period, so as to have struck out new roots, they should always be removed with balls of earth, as where this is not attended to they grow weak. On this account the exact period for removal should be carefully observed. It is necessary, on taking up the choice kind of bulbous roots annually, to separate the offsets for increase, as well as to prepare the earth of the beds and borders afresh, to promote the fineness of the succeeding year's bloom. The inferior sorts of bulbous roots should also be removed every other year, or as often as their offsets are considerably increased; for when increased into large bunches they cramp each other in growth, and produce small ill-nourished flowers.

Planting out and After-culture.—With respect to the seasons for planting out bulbs after proper drying, it is recommended as the best practice to plant the spring kinds in the beginning of the autumn, such as in the latter end of September, or beginning of the following month; and those of the summer flowering in October, or the beginning of November; and those of the autumn blowing in the latter part of July, or in the following month; too early and too late planting being equally to be avoided, as when put in too soon, the flowers are liable to be injured by being too forward if the winter and early spring prove severe; and when delayed too long, they are apt previously to exhaust themselves by forming roots. The offsets of bulbs should in general be put into the ground a considerable time before the periods of planting out the full-sized roots; those taken from coated or laminated bulbs mostly requiring to be immediately replanted. With respect to the disposal of bulbs in planting, the larger and more choice sorts require beds a little rounded, of three, four, or more feet in width, according to circumstances; the smaller sorts appear best in patches in the common borders, in clusters of three, four, or five together, according to their respective height. With the large sorts, one in a place is sufficient. The fancy sort of bulbs when planted in beds are usually put in rows eight or nine inches apart, and from five to seven inches distant, in proportion to their height. Some prefer less room, but where a strong blow is required these distances are not too great. The depths of setting bulbs are in general according to their sizes or growths, as three or four inches from their upper parts, though some sorts will rise from a considerable depth, as six inches or more, and others from still greater, which has induced some persons to plant them to such depths as are sufficient to prevent their being injured by digging over the surface ground. Different methods are employed in planting bulbs, such as putting them in by the dibble, or in drills drawn by a hoe. The latter is in general to be preferred, as they are apt to be hollow in dibbling, while, by placing them in a drill they may be gently pressed into the soil, and be perfectly covered up. When they are set in beds, the best method is to draw off the mould of a sufficient depth to one side, leaving the surface perfectly level, watering it a little in dry seasons, and then forming it into proper squares, placing a bulb in the middle of each, and covering them with the mould drawn off so as to leave the bulbs in an upright position. After the bulbs have been put into the earth, if the weather continue very dry, a little water should be sprinkled over the beds or other places, to forward their vegetation and prevent their rotting. Occasional protection will be necessary in raising the more choice sorts of bulbs; and before they appear, during the winter, the beds should be sheltered from too much wet, in order to guard against the effects of succeeding frosts. When they first present themselves above the ground also, they should have the protection of an awning of cloth, mats, or other contrivances at night when the weather is severe; but these should not remain on in the day time when the weather is tolerable. Some sort of covering of the same sort is likewise necessary when they are in bloom, to shield them from the sun and rain, and continue them much longer in a perfect state of flowering.

UNCERTAIN SIGNS OF DEATH.

The cessation of pulsation in the heart and the arteries, and coldness of the body, are commonly thought to be certain signs of death; but the researches of science have proved them to be very fallacious. A more certain sign is the suspension of respiration, for it cannot be continued many minutes without actual death supervening; whereas the action of the heart and arteries may be suspended for a considerable time, if respiration be still carried on, however obscurely, and yet these organs be again awakened to activity. The first object, therefore, in supposed death, is to ascertain whether respiration still continues. This can, in many instances, be perceived by baring the thorax and abdomen; since it is impossible for breathing to be carried on for many seconds without the influence of the respiratory muscles, the effect of the action of which is to elevate the ribs and depress the diaphragm, so as to push forward the sternum, and cause a momentary swelling of the abdomen. It is of great importance to the young practitioner to accustom his eye to judge accurately of these movements, as the ordinary methods of applying a mirror to the mouth, or a downy feather near it, are both liable to error. If the mirror be warmer than the expired breath, no sign can be obtained by it, because the breath is not condensed upon it; or, the insensible perspiration from the hand of him who holds it may sully its surface; whilst "the light and weightless down," if confided in, will delude more than the prince, who is thus described as having been deceived by it, when carrying off the crown from the pillow of his royal father:—

> "By his gates of breath,
> There lies a downy feather, which stirs not:
> Did he respire, that light and weightless down
> Perchance must move."

Another symptom, the opacity and want of lustre in the eye, is equally fallacious; even the thin slimy membrane which covers the cornea in the eye of the dead, which breaks in pieces when touched, and is easily removed from the cornea by wiping, sometimes is formed many hours before death has occurred. In several instances, also, this appearance does not present itself even after death; as, for instance, in cases of poisoning by hydrocyanic acid, in which the eye retains all its lustre for hours after death; and the iris even contracts when approached by a bright light. This sign, therefore, when taken alone, is of no value.—The state of collapse, which is one of the symptoms of cholera asphyixa, has demonstrated how little is the value of *coldness* of the body as a sign of death. In that singular disease, the coldness which accompanies the state of collapse is that of ice, and during it no pulsation can be perceived, even at the heart; yet the person lives and breathes, and frequently recovers. Drowned persons, also, in whom animation is only suspended, and who may be recalled to life, are always cold; whereas in some diseases, apoplexy, for example, a certain degree of warmth is perceived for many hours.—Paleness and lividity of countenance always accompany the above state of collapse; the body even becomes blue: this sign, therefore, which is usually set down as one indicating death, is of less value than any others. Cases, on the other hand, have occurred in which the countenance has remained unchanged a considerable time after death; and in some instances, as Dr. Paris has remarked, "its colour and complexion have not only been preserved, but even heightened:" as if the spirit, scorning the blow which severed it from mortality, had left the smile it raised upon the moveless features; or, as Shakespeare would express it,

> "Smiling, as some fly had tickled slumber;
> Not as Death's dart, being laugh'd at."

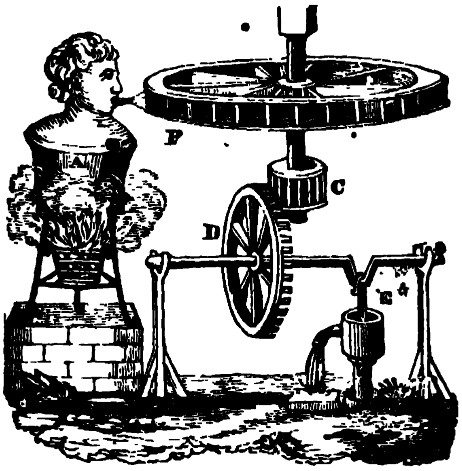
From these, and other observations, by the same writer, Dr. A. T. Thomson, it is evident, that there are no certain signs that a person is truly dead, except the total cessation of respiration, and the commencing putrefaction of the body.

STEAM AND THE STEAM ENGINE.

(Resumed from page 294.)

Soon after the time at which De Caus published an account of his contrivances; namely in 1629, a scheme was given by an Italian architect and engineer, named Branca, which exhibits a different mode of applying the agency of steam; in this, its impulsion on a wheel produced a rotatory motion. The following cut shows the picturesque apparatus he has given to illustrate his invention.

A is a boiler with a negro's head attached; from the mouth of the figure issues a tube, and when a fire is placed beneath the boiler, the steam issuing from the tube, strikes against the float-boards of the horizontal wheel B. To the spindle of B is attached the trundle C, which works the cogged wheel D, and by its means the crank and pump rod E. In the original it was made to move stampers up and down, which worked into large iron mortars, where drugs were placed to be pounded. A slight inspection of Branca's diagram will convince us, that his series of wheels, and the stampers and mortars, are introduced more to show how steam may be applied, than that it ever was so. His book besides is avowedly a collection of machines invented by others; and this mode of moving a wheel by steam, is probably, therefore, an idea of which he is the mere illustrator. If not, it is only a slight modification of the older Œlipiles, and has no connection whatever either in structure or principle with the steam engine now in use. Branca gives another figure in his volume, in which he shows the *smoke*, rising through a pipe from a *small* smith's forge, moving a wheel, which communicates motion by other wheels to cylinders, for flattening iron bars. This by the smoke and that by the steam, may therefore be equally efficient; and both, probably, have similar pretensions to being considered as never having been applied in practice. The picturesque arrangement of his apparatus will be readily admitted as a proof of the position, at least, that Branca was a man of taste, as well as a person of ingenuity.



The year following that of the publication of Branca's book, the ingenious Cornelius Drebbel, who has left so great a reputation for ingenuity, and so few of whose works remain on which it was founded, put in practice the device, which has been described as producing the sounds of the "Egyptian Idol;" a musical instrument, which being set in the sunshine, would of itself render a soft and pleasant harmony, but being removed into the shade would presently become silent. The reason of it was this:—The warmth of the sun, working upon some moisture within it, and, rarefying the inward air unto so great an extension, that it must needs seek a vent or orifice, did thereby give several motions to the instrument.

Considering that the Marquis of Worcester really put in practice all the wonderful contrivances mentioned in his "Century of Inventions," we shall be bound to cede to him the real invention of the steam engine: for, until he showed how a reciprocating action was to be kept up, there was nothing which could claim to be so considered. With this extraordinary man's public character we have nothing to do; though his career was checkered with casualties, his conduct appears devoted to his royal master Charles—in whose service his family were exterminated; his castle (Ragland Castle) besieged, taken, and destroyed; himself reduced to destitution, oppressed with debt, and without resources. During the ascendancy of the parliament, he mostly resided abroad, but coming to London with a commission from his royal master, he was taken prisoner, and for many years confined a close prisoner in the Tower.

The tedium of his long imprisonment was beguiled by mechanical amusements, which, it is gathered from other sources, he diligently followed even in the times of his brightest fortunes, and in situations apparently the most unpropitious for his being able to spare the necessary leisure and attention. At his enlargement, neither the dilapidation of his fortune, the love of pleasure, which was strongly implanted in him, nor his own increasing infirmities, had any effect in damping the ardour of his enthusiasm.

The desire of being useful to his country, in the way which his experience pointed out was of all others the most effective, gained strength as his offers of service were rejected. Yet he solicited but for that cheapest of all patronage, the countenance only of men in power, to ensure a fair trial for his inventions; for notwithstanding his deep embarrassments, so sanguine was he of the practical value of his projects, that he offered to make all the experiments at his own expense. The passage is curious. "Be pleased," he says to parliament, "to make use of me and my endeavours, to enrich them not myself; such being my onely request unto you, spare me not, in what your wisdoms shall find me useful, who do esteem myself, not onely by the *act* of the water-commanding engine, (which so chearfully you have past,) sufficiently rewarded, but likewise with courage to do ten times more for the future, and my debts being paid, and a competency to live according to my birth and quality settled, the rest I shall dedicate to the service of our king and countrey by your disposals; and esteem me not the more, or rather any more, by what is past, but what's to come; professing really from my heart that my intentions are to outgo the six or seven hundred thousand pounds already sacrificed, if countenanced and encouraged by you; ingenously confessing that the melancholy which hath lately seized upon me, (the cause whereof none of you but may easily guess,) hath, I dare say, retarded more advantage to the public service than modesty will permit me to utter. And now revived by your promising favours, I shall infallibly be enabled thereunto, in the experiments extant and comprised under these heads, practicable with my directions, by the unparalled workman, Caspar Kaltoff's hand, who hath been these five-and-thirty years as in a school under me employed, and still at my disposal, in a place by my great expenses made fit for public service, yet lately like to be taken from me, and consequently from the service of king and kingdom, without the least regard of above ten thousand pounds expended by me, and through my zele to the common good."

The book to which he alludes, as containing the "heads" of his experiments, was published in 1663, under the title of "A century of the names and scantlings of such inventions, as at present I can call to mind to have tried and perfected, which, my former notes being lost, I have, at the instance of a powerful friend, endeavoured, now in the year 1655, to set down in such a way, as may sufficiently instruct me to put any of them in practice."

The novelty of the greater number of the hundred propositions or descriptions of which this volume consists, and the wonderful nature of others, cast an air of improbability over the whole; the noble author was charged with describing many things which he wished were invented, rather than machines which he had actually constructed. And even those who have been warmest in praise of his genius, and have spoken in favorable terms of some of his "scantlings," have found it necessary to enter their protest against others, in order to save their own consistency.

Yet this collection of descriptions bears internal marks of being what it professes to be, drawn up from actual trials of machines in existence. On an attentive examination of the general scope of his inventions, they will appear to have been suggested, the greater number, by the wants of his accidental situation, and a small number by those of his station. To a statesman employed in highly confidential negociations, the secrecy of his correspondence would be of great importance; to a traveller the security of his locks; a soldier is mainly interested in his arms, at times in scaling a fortification, or transmitting intelligence in the dark; and the projector of a water-company could not fail of laying his ingenuity under contribution, to devise a mode of raising water above its level. These classes comprise the greater part of his hundred inventions; and when we learn that, for so long a period as thirty-five years, he employed an expert mechanic in his various projects, it is a matter of wonder that his inventions were not more numerous. And in fact, he says that they were so; for he observes, "that he has omitted many, and some of three sorts not willingly set down, lest ill be made thereof;" but that such things were actually within his knowledge is quite clear, for he promises to "set them down in his own cipher, not to be concealed when duty or affection obliges him." It is also very generally admitted, that not a few of his improbable things are trifles, while others usually conceded to him as conveying clear notions, are decidedly machines of importance; and all are agreed, that since his book was published, many similar contrivances have been put in practice.

There is nothing therefore preposterous in the opinion, that *all* the inventions described in the "Century," had been put by the noble mechanic to the test of experiment. Of one, which is the subject of the sixty-eighth proposition, we have fortunately very conclusive evidence *of its having been actually erected*, and this may be considered as that one the most obscurely hinted at, and described as capable of the most improbable performance of all his inventions. The announcement is as follows:—

"An admirable and most forcible way to drive up water by fire, not drawing or sucking it upward, for that must be as the philosopher calleth it, *infra sphæram activitatis*, which is but at such a distance, but this way hath no bounder, if the vessels be strong enough; for I have taken a piece of a whole cannon, whereof the end was burst, and filled it three-quarters full, stopping and screwing up the broken end, as also the touch-hole, and making a constant fire under it; within twenty-four hours it burst, and made a great crack, so that having found a way to make my vessels so that they are strengthened by the force within them, and the one to fill after the other, have seen the water run like a constant fountain forty feet high; one vessel of water rarefied by fire driveth up forty of cold water; and a man that attends the work, is but to turn two cocks, that one vessel of water being consumed, another begins to force and re-fill with cold water, and so successively.

"An engine so contrived, that working the *primum mobile* forward or backward, upward or downward, circularly or corner-wise, *to* and *fro*, straight, upright, or downright, yet the pretended operation continueth and advanceth, none of the motions above-mentioned hindering, much less stopping, the other; but unanimously and with harmony agreeing, they all augment and contribute strength unto the intended work and operation; and, therefore I call this a *semi-omnipotent engine*, and do intend that a model thereof be buried with me.

"How to make one pound weight to raise an hundred as high as one pound falleth, and yet the hundred pound descending, doth what nothing less than one hundred pounds can effect.

"Upon so potent a help as these two last-mentioned inventions, a waterwork is, by many years' experience and labour, so advantageously by me contrived, that a child's force bringeth up, an hundred foot high, an incredible quantity of water, even two feet diameter, so naturally, that the work will not be heard into the next room; and with so great ease and geometrical symmetry, though it work day and night from one end of the year to the other, it will not require forty shillings reparation to the whole engine, nor hinder one day's work; and I may boldly call it *the most stupendous work* in the world: and not onely with little charge to drain all sorts of mines, and furnish cities with water, though never so high seated, as well as to keep them sweet, running through several streets, and so performing the work of scavengers, as well as furnishing the inhabitants with sufficient water for their private occasions; but likewise supplying rivers with sufficient to maintaine and make them portable from towne to towne, and for the bettering of lands all the way it runs. With many more advantageous and yet greater effects of profits, admiration, and consequence; so that, deservedly, I deem this invention to crown my labours, to reward my expenses, and make my thoughts acquiese in the way of further inventions."

(To be continued.)

STRAW PLAT.

(Resumed from page 303, and concluded.)

The chips are whitened, either before or after manufacture, by steeping them in cold soapy water, colored with a small portion of indigo; after which they are exposed for some days on the grass, where they are frequently sprinkled with clear water, as they must not be allowed to become dry.

Hats manufactured from this material recommend themselves by their extreme lightness, while they are sometimes made to assume a delicate and tasteful form; they are however at best but very fragile from their want of flexibility and firmness. The French have endeavoured to impart to them something of these qualities by the union of another substance, making hats composed of willow chips and whale-bone. The warp of this texture is formed of whale-bone and *willow chips*, one of the former and two of the latter alternately, and the woof is entirely composed of willow chips. Hats made of this mixture are found much more durable than those made wholly of wood shavings.

Platting of straws, grasses, and chips into hats, and different articles for wear, is far from being confined to Europe, or to civilised countries. The art is indeed found to obtain in different degrees of extent and excellence in nearly every part of the world. In the southern provinces of China, where, in summer, the population use no other head covering, and where the Mandarins wear these hats with tremendously wide brims, the quantity of straw platted is prodigious. In Japan, in proportion to the population, the consumption is almost equally great. "When on a journey," says Thunberg, "all the Japanese wear a conical hat, made of a species of grass platted and tied with a string." He also observed, that all the fishermen wore hats of the same material and shape. But in addition to this extensive use, the Japanese hardly ever wear any shoes or slippers but such as are made of platted straw. "This," remarks the same excellent traveller, "is the most shabby and indifferent part of their dress, and yet in equal use with the high and the low, the rich and the poor. They are made of rice-straw platted, and by no means strong." They cost, however, a mere trifle; they are found exposed for sale in every town and in every village, and the pedestrian supplies himself with new shoes as he goes along, while the more provident man always carries two or three pair with him for use, throwing them away as they wear out. "Old worn-out shoes of this description are found lying every where by the sides of the roads, especially near rivulets, where travellers, on changing their shoes, have an opportunity at the same time of washing their feet." In very wet weather they use wooden clogs, which are attached to their straw-platted shoes by ties also made of straw plat. People of very high rank sometimes wear slippers made of fine slips of rattan neatly platted.

The natives of Tonquin wear also broad-brimmed hats of platted straw or reeds, occasionally platting strips of the palmeto leaf for the same purpose. But not to enumerate many other comparatively civilised people, we find the wild Indians of both the Americas, the natives of the South Sea Islands, the Negroes and Hottentots of Africa, and even the poor savages near the Polar regions, all acquainted with the art of platting strips of wood, grasses, or sea-weeds, and some of them producing, merely by hand, textures which we, assisted by all the agency of machinery, could scarcely rival.

A very pretty and endurable kind of straw plat, made in South America, is familiar to amateurs of cigars. "A fabric highly esteemed in all the Spanish possessions," says a recent traveller, "is that of a species of grass, which is bleached and platted into various articles, such as pouches and cigar-cases, of extreme regularity and fineness. Hats of the same material, but coarser, are exported in large quantities, and found well adapted to warm climates. I could obtain very little information respecting the raw material, farther than that it grew on the coast to the northward in great profusion."

CHEMICAL CHANGES PRODUCED BY MALTING.

It is a fact, which must strike the most superficial observer, that the structure of the kernel of a barley-corn is, in appearance, very different indeed from that of a grain of malt. The kernel of raw barley is heavy, hard, horny, and in a slight degree transparent. The kernel of a well-malted grain is light, soft, floury, and perfectly opaque. The cause of these differences should properly be sought in the analysis of grain in the two different states.

The analysis of barley-meal has been attempted by two chemists, Einhoff and Proust; but the results are so extremely discordant, that there is but little use in adducing either of them. There is, however, a statement made by Proust, which it would be improper to neglect. He affirms that barley contains a peculiar proximate principle, which, from the Latin name of the grain, he has called *hordein*. He describes it as a yellow, woody powder, granular to the touch, and resembling sawdust in appearance. It is insoluble in water, either boiling or cold. In the process of malting, this hordein disappears in great quantity, and it is resolved chiefly into starch and sugar; certain quantities of which had previously existed ready formed in the raw barley. According to Proust, the following is a comparative estimate of the principles of unmalted and malted barley in one hundred parts:—

	Barley.	*Malt.*
Yellow resin	1 part and	1
Gum	4 parts	15
Sugar	5	15
Gluten	3	1
Starch	32	56
Hordein	55	12
	100	100

The analysis of Einhoff, beside adding albumen, volatile matter, and phosphate of lime to the foregoing ingredients, represents the quantity of starch to be more than double what is stated by Proust; and if to the starch we add the hordein, still the sum will not reconcile the analyses. The proportion of sugar corresponds in both estimates almost precisely. But the most remarkable circumstance in the whole is the total omission of the fixed oil which exists in barley, and which has been described by Fourcroy and Vauquelin as amounting to a hundredth part; and afterwards by Dr. Thomson. This oil is of importance; it is of so permanent a nature as to escape alteration in the processes of fermentation and distillation; for it is obtained abundantly in the distillation of whiskey, in shreds.

In some of its properties this oil resembles oil of roses obtained by distillation; it is concrete, and almost as solid as tallow, even in summer: by peculiar management it may be made to crystallise in blades; it is somewhat soluble in alcohol, and may be precipitated from its solution by the effusion of water. The oil is volatile, and distils over with water: it dissolves oxide of copper, and forms a green compound: the color of the oil, when newly distilled from wash, is variable; sometimes being pale green, sometimes white, and sometimes of no decided color: time renders it rancid: its natural smell is not agreeable; it mostly resembles distillers' *faints:* when dissolved in diluted alcohol, it communicates to it very nearly the smell of what, in Ireland, is called *potteen* whiskey; and good judges were deceived by it. What is called the *whiskey smell* of spirit is owing to a small quantity of this oil held in solution. It is not so volatile as alcohol: hence frequent rectifications of common spirit afford a product having less and less peculiar smell: hence, in the distiller's process, the singlings contain much oil, because they were distilled at a high temperature, on account of the great quantity of water present: hence, the spirit produced first in the rectification of singlings is much freer from oil than the latter portions, when the temperature rises; and hence the very last products from the singlings have so disagreeable an odour, because then the oil comes over abundantly. The points of resemblance between this oil and oil of roses are their solidity, their volatility, their leaving a greasy stain on paper, which requires a strong heat to expel, their tendency to rancidity, their crystallisability, and the uncertainty of color. The properties just explained place these two oils as the link of connection between what are called fixed and volatile oils.

Dr. Thomson is of opinion that the hordein should not be considered a peculiar proximate principle; and that it is merely starch in a particular state, somewhat similar to the fibrous matter of potatoes. Malting converts it partly into sugar, and partly into common starch, by destroying a certain unknown glutinous substance, which glues the particles of it so firmly together. Yet the presence of substance in barley-meal in so great a quantity as more than one half of the whole weight; its being woody, and insoluble in water whether cold or boiling; its disappearing during the malting; and the increase of the gum, sugar, and starch, in consequence; are properties not attributable to any component part of any grain with which chemists have hitherto been acquainted. Hence, in strictness, we are bound to admit hordein as a peculiar substance.

As to the original question just proposed, and which brought the investigation of Proust under consideration, it still remains to be answered, what is the cause of the difference of their mechanical structure? And although the analyses of Einhoff and Proust differ so materially, yet chemists agree that raw barley, amongst its other ingredients, contains gluten, gum, and sugar; and there is even tolerable accordance in the quantities assigned. One hundred parts of barley-meal contain about 3½ parts of gluten, 4⅔ of gum, and 5⅔ of sugar. Now these are all of a glutinous nature, calculated to bind the starch and the other ingredients into a solid mass of great hardness, such as we know a barley-corn to be. For such is the hardness of gluten, that it has been used to join fragments of pottery. The following is a fact illustrative of this statement:—If barley, reduced to the finest powder and the husk removed, be made into a paste with water, rolled into grains resembling the original barley, and exceedingly well dried before a brisk fire, but not scorched, they become almost as hard as the natural grain. But this powerful cohesion has taken place between particles which had been already disintegrated, and removed from each other. How much more powerful must be the cohesion of particles bound together by gluey matter, which had grown along with the ingredients of the corn, which cemented—not particles formed by the artificial process of grinding—but the ultimate particles of which that kind of matter is composed. In such a case, it is not wonderful that particles so much more closely approximated, and so much more intimately penetrated by the cement, of which two of the ingredients are perfectly transparent, and the third a good deal so, should be so affected as to be at least horny, if not in a slight degree transparent, as we find a ripe dry barley-corn to be.

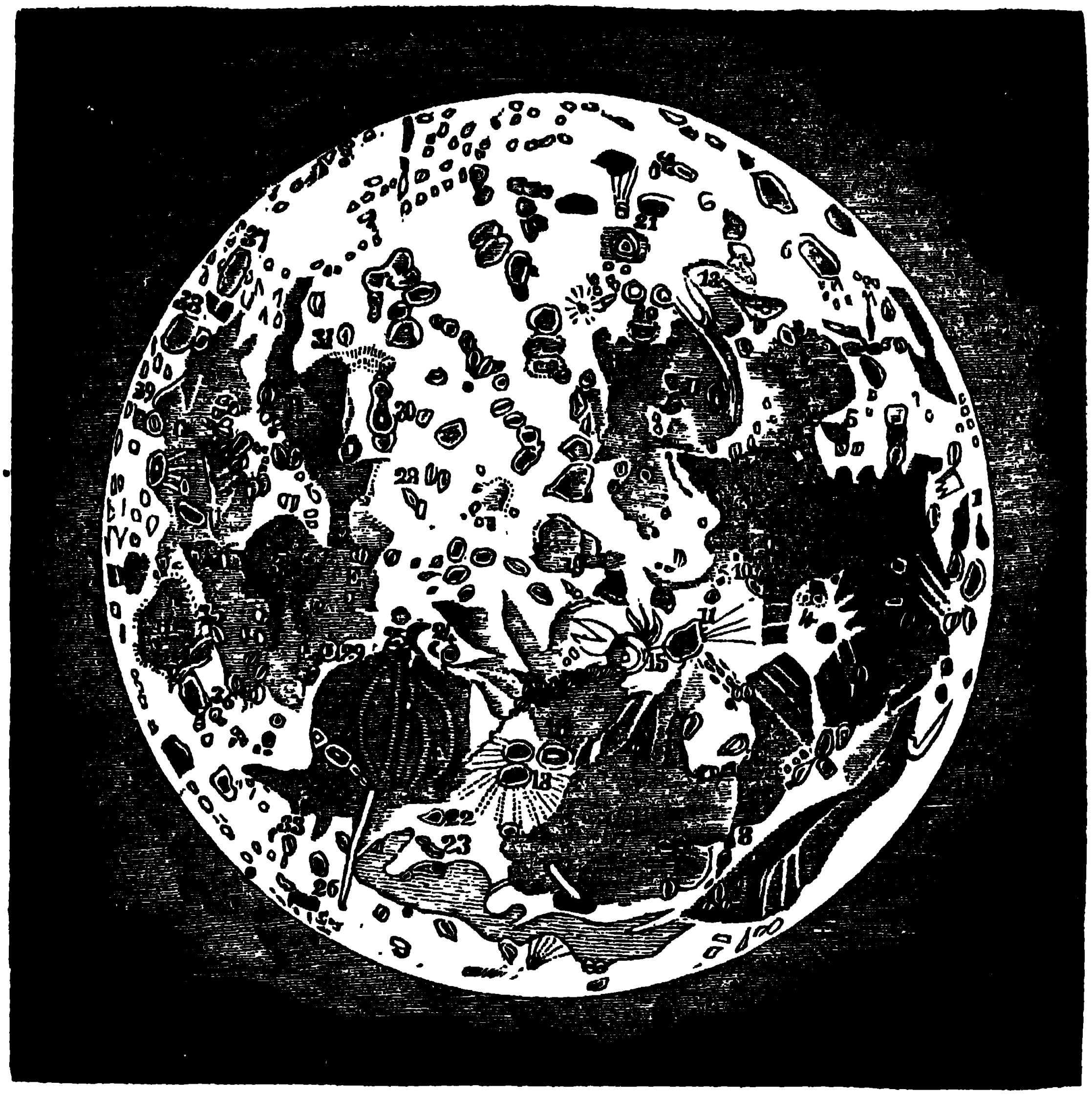
But when barley is steeped in water with a view of malting, the cement is softened, the particles now cohering with but little force, are separated to a greater distance from each other, so that the specific gravity is lessened by the absorption of water and consequent swelling of the grain, and perhaps by the evolution of the carbonic acid. During the progress of germination, the quantity of the chief cement, the gluten, is lessened from three parts to one, by chemical changes in it; and, in short, the whole constitution is subverted.

It is a matter of opinion, admitted by some and denied by others, that the change effected in barley by malting is complete; that it affects every ingredient of the grain; and that the whole substance is converted into new matter, which did not previously exist in the grain. What the nature of this new matter may be is not yet agreed on. There are two opinions. It is found that hot water is capable of dissolving away every thing from malt, except the husk. This, it may be supposed, could not happen unless there was a total change effected in the starch and gluten of the barley. Starch, it is true, is soluble in boiling water; the result, however, is not a solution, but a well-known jelly; which becomes even more stiff by cooling. But the solution obtained from malt is perfectly fluid, whether hot or cold. From the disappearance of the starch, and the obvious formation of sugar, it has been supposed that the result and object of malting are the total conversion of the starch into sugar.

But a different view may be taken. It may be supposed that, during the malting process, the change of starch into saccharine matter is but partial; that the malt still contains much unaltered starch; and that, by the action of hot water, the conversion into saccharine matter is nearly completed. In short, it has been conceived, and with much probability, that the sugar-forming process is resumed and continued during the action of the hot water.

GALVANIC PLANT PROTECTOR.

Mr. Cuthbert, of Clayton-square, Liverpool, has successfully applied the galvanic principle to the preservation of plants, from the attacks of slugs or worms. This invention, which perfectly secures dahlias and other delicate plants from the attacks of those voracious pests of the flower garden, the mollusca, must be highly acceptable to all engaged in their culture. After a trial of twelve months by the inventor, not a plant was injured that had the protection of these galvanic circles, although during the same period plants on all sides suffered severely that were not so protected. The protector consists of a conical ring of zinc about four inches in height, the top end flanked off about a quarter of an inch, and cut into numerous vandyked points; immediately under is a ring of copper neatly fitted. It is thus used:—The bottom of the zinc ring is pressed into the soil until the lower edge of the copper ring is about one inch and a half above the surface; care being taken to inclose within the ring the rods of such plants as may require them, otherwise the mollusca find a road to the plant by the rods. The mollusca may crawl into the zinc with impunity, but, on coming in contact with the copper, will receive a galvanic shock, and immediately turn away or fall to the ground. If the largest of this tribe attempt to stretch across and above the copper belt, avoiding contact, they would be incapable of holding by the points. The protector acts in wet or dry weather, and is always in action. Its appearance in use is like a flower-pot; and its cheapness, utility, and durability, must insure its general adoption.



ECLIPSES AND SPOTS UPON THE MOON.

To observe an eclipse of the moon, in such a manner as to be useful to geography and astronomy, it will be necessary, in the first place, to have a clock or watch that indicates seconds, and which you are certain is so well constructed as to go in an uniform manner: it ought to be regulated some days before by means of a meridian, if you have one traced out, or by some of the methods employed for that purpose by astronomers; and you must ascertain how much it goes fast or slow in twenty-four hours, that the difference may be taken into account at the time of the observation.

You ought to be provided also with a refracting or reflecting telescope, some feet in length; for the longer it is, the more certain you will be of discerning exactly the moment of the phases of the eclipse; and if you are desirous of observing the quantity of the eclipse, it should be furnished with a micrometer.

When you find the moment of the eclipse approaching, which may be always known either by a common almanac, or the Ephemerides published by the astronomers in different parts of Europe, you must carefully remark the instant when the shadow of the earth touches the moon's disc. It is necessary here to mention, that there will always be some uncertainty on account of the penumbra; because it is not a thick black shadow which first covers the moon's disc, but an imperfect one that thickens by degrees. This arises from the sun's disc being gradually occulted from the moon; and hence it is difficult to fix with exactness the real limits of the shadow, and the penumbra. Here, as in many other cases, observers are enabled by habit to distinguish this boundary; or at least prevented from falling into any great error.

When you are certain that the real shadow has touched the moon's disc, the time must be noted down; that is to say, the hour, minute, and second, at which it happened.

In this manner you must follow the shadow on the moon's disc, and remark at what hour, minute, and second the shadow reaches the most remarkable spots: all this likewise must be noted down.

If the eclipse is not total, the shadow, after having covered part of the lunar disc, will decrease. You must therefore observe in like manner the moment when the shadow leaves the different spots it before covered, and the time when the disc of the moon ceases to be touched by the shadow, which will be the end of the eclipse.

If the eclipse is total, so that the moon's disc remains some time in the shadow, you must note down the time when it is totally eclipsed, as well as that when it begins to be illuminated, and the moments when the shadow leaves the different spots.

When this is done, if the time of the commencement of the eclipse be subtracted from that of the end, the remainder will be its duration; and if half the duration be added to the time of commencement, the result will be the middle.

To facilitate these operations, astronomers have given certain names to most of the spots with which the moon's disc is covered.

The usual denominations are those of Langrenus, who distinguished the greater past of them by the names of astronomers and philosophers who were his contemporaries, or who had flourished before his time. Some others have been since added; but there was no room for the most celebrated of the moderns, such as Huygens, Descartes, Newton, and Cassini. Hevelius, far more judicious in our opinion, gave to these spots names taken from the most remarkable places of the earth: in this manner he calls the highest mountain of the moon, Mount Sinai, &c. This however is a matter of indifference, provided there be no confusion. We have here subjoined a representation of the moon, by means of which and the following catalogue they can be easily known, on comparing the numbers in the latter with those in the former:—

1. Grimaldi
2. Gallileo
3. Aristarchus
4. Kepler
5. Gassendi
6. Schikard
7. Harpalus
8. Heraclides
9. Lansberg
10. Rheinhold
11. Copernicus
12. Helicon
13. Capuanus
14. Bullialdi
15. Eratosthenes
16. Timocharis
17. Plato
18. Archimedes
19. Isle of the Middle Bay
20. Pittacus
21. Tycho
22. Eudoxus
23. Aristotle
24. Manilius
25. Menelaus
26. Hermes
27. Posidonius
28. Dionysius
29. Pliny
30. Catharina, Cyrillus, Theopilus
31. Fracastorius
32. The Acute Promontory
33. Messala
34. Promontory of Dreams
35. Proclus
36. Cleomedes
37. Snellius and Furnerius
38. Petau
39. Langrenus

[illegible]. Taruntius.

A Sea of humours
B Sea of clouds
C Sea of rain
D Sea of necta
E Sea of tranquility
F Sea of security
G Sea of fecundity
H Sea of crises.

TIME TOLD BY A SHILLING.

We insert the following paper from the *National Advertiser*, because we have been repeatedly asked for an explanation of the phenomenon; and to neglect it, would be to treat very numerous correspondents with neglect; at the same time, we do not take for our own the surmises contained in the following, on the contrary, believe that there is no truth whatever in the experiment, and that the success of it depends entirely upon our knowing, or, at least, guessing, beforehand the actual time; and that we may make it succeed or not at our pleasure. Experiments upon the subject by a person previously acquainted with the *wished-for* result is not a fair test; let a stranger, or a child who never has heard of the experiment, or a person when just awake try it, the light being such that he cannot guess at the time of day, and if it then succeed more than once, we will admit that there is something to argue upon, but not otherwise.

"'However improbable the following experiment may appear, it has been proved by repeated trials:—Sling a shilling or sixpence at the end of a piece of thread by means of a loop. Then resting your elbow on a table, hold the other end of the thread betwixt your fore-finger and thumb, observing to let it pass across the ball of the thumb, and thus suspend the shilling into an empty goblet. Observe, your hand must be perfectly steady; and if you find it difficult to keep it in an immoveable posture, it is useless to attempt the experiment. Premising, however, that the shilling is properly suspended, you will observe, that when it has recovered its equilibrium, it will for a moment be stationary; it will then of its own accord, and without the least agency from the person holding it, assume the action of a pendulum, vibrating from side to side of the glass; and, after a few seconds, will strike the hour nearest to the time of day: for instance, if the time be twenty-five minutes past six, it will strike six; if thirty-five minutes past six, it will strike seven; and so on of any other hour. It is necessary to observe, that the thread should lay over the pulse of the thumb, and this may in some measure account for the *vibration* of the shilling; but to what cause its striking the precise hour is to be traced, remains unexplained; for it is no less astonishing than true, that when it has struck the proper number, its vibration ceases, it acquires a kind of rotary motion, and at last becomes stationary, as before."

(To the Editor of the National Advertiser.)

Sir,—Having read in your highly valuable paper the above notice, I tried a series of experiments; and the *fact* of the hour being "told by a suspended shilling," I have proved, I think, for every hour in the day; but I honestly confess I cannot explain it; but perhaps this may meet the eye of some who may be able to do so, and I therefore give my simple trials, hoping thereby that the true cause may be elicited. Animal magnetism is beyond me, but nervous influence was explained to me by "Osler," as being electrical, and I have never had reason to doubt it. That electricity or magnetism does exert its power without contact, we all know; witness the galvanometer, causing the deflection of the magnetic needle. As I cannot prove that it is electrical, I shall leave the matter in other hands, merely adding that a friend of mine explained it by saying it was the *mind* which produced the effect. This is beyond me again: but I will give my experiments, and shall be happy to learn, through your columns, that others have proved the correctness of my trials.

Iron, copper, brass, silver, and gold, all produced the effect when suspended. Glass will not act when suspended.

The old penny acts very well, but the shilling better; but the fourpenny-piece I preferred. I fancied that the vibration took place better in a dry warm glass.

1. Rummer, or goblet (the best form) always answered when dry.

2. Glass jar, 4½ inches diameter, answered very well when dry, would not when water was poured into it.

3. When the coin was suspended by silk instead of cotton, I could not make it act.

4. Unless the elbow rest on the table, no effect —but when resting on the table it answers as well with the left as with the right arm.

5. Brass cup, 4 inches in diameter. The suspended piece vibrated but never touched the sides, and was soon at rest.

6. Gas receiver, with brass cap and stop-cock— removed the stop-cock (by which the bottom was open), placed it to stand with the brass end on the table: vibration as in No. 5, but nothing more.

7. Goblet with fourpenny-piece at the bottom; effect like No. 6.

8. Goblet, at nine o'clock, with suspended shilling: struck the number nine—was again tried, and whilst in the act of striking the glass (and which it had done five times), a person slipped in a fourpenny-piece, it struck no more, and the vibration ceased in a short time. Another case at ten o'clock, as soon as it had touched the glass twice, a shilling was thrown into the goblet. It struck no more.

9. Large lamp glass, with a cork bottom (which would hold water), this would not act.

10. Wet glass, like No. 9.

11. Brass and iron balls. I did not succeed so well with these, the iron ball struck the number, but the brass ball went on until it struck 25, and would have continued, but I altered my position. I never heard the shilling strike more than 12.

I will add but a few remarks to the above. I remarked on many occasions, that should the suspended coin fail of striking all the hours consecutively, it will vibrate on until it obtains sufficient momentum to perform its work. In striking 12, it touched the glass seven times, then turned round and kept moving for several seconds; but at last assumed its pendulum-like motion, and touched the glass five times more. I have seen this with others performing it, the numbers were not seven and five, but varied.

The operator must have a steady hand and arm, and a fair proportion of patience.

I should say, I met a gentleman who told me never *could* do it, and another informed me I never failed.

It appears that a glass vessel open at bottom will not answer, neither a wet one, nor when water is in it, nor metal, nor when a metal cup is used, nor when the pendulum is not of metal, nor the string of silk, and that its best effect is produced when the glass is warm. I hope these trials of mine may be proved correct by others, and abler hands; and should they be so, we may then say they *look like* electrical action.

ROBERT WALTER BYERS, F.L.S.

Tremador, near Caernarvon, Nov. 23, 1841.

EFFECT OF HEAT UPON CRYSTALS.

The very curious subject of the influence of heat upon double refraction has been recently investigated by Professor Mitscherlich, of Berlin; but we regret that it is out of our power to give anything more than a meagre account of some of his results.

In uncrystallised bodies, and in all crystals which have no double refraction, a rise of temperature throughout the whole mass produces an equal expansion in all directions, without any change of figure. With doubly refracting crystals the case is different. When calcareous spar is heated, it dilates in the direction of its axis of double refraction; but Professor Mitscherlich found that in all other directions at right angles to this axis it contracts, so that there must be a line inclined to the axis in which there is neither dilation nor contraction. Hence the angles of the crystal are changed by heat, being diminished (by a heat from the freezing to the boiling point) 8′ 30″ in the dihedral angle at the extremities of the axis. Its form being thus brought nearer to that of the cube, which has no double refraction, its double refraction, as might have been expected, is diminished. M. Fresnel found that heat dilates sulphate of lime less in the direction of its principal axis of double refraction (in the plane of the laminæ) than in a direction perpendicular to it, a difference analogous to that of calcareous spar, but of a contrary character, as might have been anticipated from the opposite nature of the refraction of these two minerals.

These results being obtained by very nice experiments, which but few persons are able to repeat, Mr. Herschel has given the following experiment as an ocular demonstration of the truth of the general fact of unequal change of dimension by change of temperature:—"Let a small quantity of the *sulphate of potash and copper* (an anhydrous salt easily formed by crystallising together the sulphates of potash and of copper) be melted in a spoon over a spirit lamp. The fusion takes place at a heat just below redness, and produces a liquid of a dark green color. The heat being withdrawn, it fixes into a solid of a brilliant emerald green color, and remains solid and coherent till the temperature sinks nearly to that of boiling water, when all at once its cohesion is destroyed; a commotion takes place throughout the whole mass, beginning from the surface, each molecule, as if animated, starting up and separating itself from the rest, till in a few moments the whole is resolved into a heap of incoherent powder, a result which could evidently not take place had all the minute and interlaced crystals, of which the congealed salt consisted, contracted equally in all directions by the cooling process, as in that case their juxtaposition would not be disturbed."

When Professor Mitscherlich was examining the double refraction of the *hydrous sulphate of magnesia* when heated in oil, he observed that it suffered no change till the temperature reached 126° of Fahrenheit. The crystal then became opaque, and on being broken, it showed the structure of a pseudo-morphous crystal, consisting of a number of individual crystals, beginning at the surface and meeting in the inside of the original crystal. The same effect was produced at the same temperature on the *hydrous sulphate of zinc*: hence he infers that a movement of the particles of a solid body may take place, by which the particles take a new symmetrical arrangement, and form a new mineral species.

The most extraordinary fact, however, discovered by Professor Mitscherlich relates to the influence of heat on the double refraction of *sulphate of lime.* In this mineral, which has two resultant axes in the plane of the laminæ inclined 60°, these two axes gradually approach with heat till they unite, and, when further heated, they again open out on each side.

NEW DISCOVERY IN PRINTING.

The progress of discovery is so rapid, that scarcely a week passes, in which we are not called on to announce some of its wonder-working miracles. Early in October, we received, from a correspondent at Berlin, a re-print of the four pages of the *Athenæum,* (published in London only on the 25th of September,) which contained the review, and *its illustrations* of "The Porcelain Tower;" how produced, our correspondent could not inform us—but obviously not by any known process. The copy was so perfect a fac-simile, that had it reached us under other circumstances, we should never have suspected that it had not been issued from our own office—and even when our attention was thus specially directed to the subject, the only difference we could discover was, that the impression was lighter, and that there was less body in the ink; from which we infer that the process is essentially lithographic, the impression of the original page being, in the first instance, transferred by some means on to the surface of the stone or zinc plate. This, however, is but a conjecture, and our correspondent is unable to throw light on the subject. In reply to our urgent request for further information, he thus writes:—

"*Berlin, Nov.* 25.

"I have not ceased to exert myself to obtain the information you desire, but all I can collect is briefly this. The process by which these fac-simile re-prints are produced, was discovered by a gentleman at Erfurt, and is kept a profound secret. I have since seen a copy of an Arabic MS. of the thirteenth century, and of a leaf of a book printed in 1483, both of which have been produced without the slightest injury to the originals, so that your Bibliomaniacs may despair of ever again seeing an unique copy. The parties in possession of the secret are about to re-publish here the *Athenæum,* and are to commence operations with the first number of the coming year. I have seen the draft of the prospectus, in which they offer to supply the trade at the rate of three thalers (nine shillings) per annum. They will be content too, I understand, with three hundred subscribers, and from this fact, you may form a conjecture as to the probable cost of the process, which must be below what the mere paper costs you."

Now, so far as our pecuniary interests are concerned, the question is not worth a second thought. The sale of the London edition of the *Athenæum* in Germany is necessarily limited by the enormous postage charges to the principal libraries, the literary and scientific societies, and some few wealthy individuals resident in the principal cities.

But to book-publishers, more especially to the publishers of costly works, illustrated with woodcuts, it is one of vital importance. Take, for example, the admirable series of works on Natural History, by Yarrell, Bell, and others, published by Mr. Van Voorst. There can be no question that such works have had a very extensive sale all over the civilized world, for the copyright has been secured to the publisher by the enormous cost of reproducing the numberless beautiful illustrations—but here is a process by which the foreigner can reproduce the work, illustrations and all, at less than the cost of paper and press-work; and of course vast manufactories will be forthwith established, and every market, even in our colonies, inundated with these spurious editions. In proof that these are not merely conjectural or possible consequences, we may state that our correspondent further mentions, that preparations are already made to produce Knight's *Shakespere,* which is announced as forthcoming at six-pence a number. Surely, government, under these circumstances, will now bestir itself, and take active measures for the establishment of some international law for the protection of the honest men of all nations—and all nations are equally concerned. This, however, is a subject too vast to be entered on in a paragraph—and, indeed, the less necessary, as we have so often expressed our opinion. We have therefore, only to add, that, for the satisfaction of those who are so deeply interested, we shall forward the copies received from Berlin to our office, in Wellington Street, where they will be exhibited and compared with the originals.—*Athenæum.*

PHOSPHORUS.

1. This substance was discovered by Brandt in 1669. Its specific gravity is 1·77.

2. Pure phosphorus is nearly colorless, semi-transparent, and flexible. It melts, air being excluded, at 105°. Exposed to the air, it exhales luminous fumes, having a peculiar alliaceous odour. It is tasteless, insoluble in water, and proves poisonous when taken into the stomach.

3. It is found in the bones and urine of carnivorous animals; wavelite, (phosphate of alumina,) apatite, (phosphate of lime,) bog iron ore; some other ores of iron, &c.

4. Heat bones in an open fire; a white matter remains, composed principally of phosphoric acid and lime: by sulphuric acid, the greater portion of the lime may be removed; and if the residue be heated with charcoal, it removes the oxygen, and the phosphorus is converted into vapour. Beginners should not attempt such a complicated process.

5. Put a little phosphorus, previously dried on blotting paper, into a deflagrating ladle; inflame it, and put it into a dry jar of oxygen. It unites with the oxygen, and thus produces phosphoric acid, which falls down like flakes of snow.

6. Put a few grains of phosphorus into a glass jar, and cover it with boiling water; force oxygen gas out of a bladder upon it. The phosphorus being raised to the heat necessary for taking fire, only waits for the admission of the oxygen, and immediately inflames.

7. Place a thin slice of dried phosphorus, (about a quarter of a grain,) between a few folds of writing paper; rub this with a glass rod, and the heat produced by the friction soon inflames the phosphorus.

8. Hold a stick of phosphorus by a pair of pincers, and draw lines with it upon a board in a dark room; wherever the phosphorus touches the wood, a portion is absorbed, which retains its luminousness for some time.

9. Into a very small retort put a few grains of phosphorus, and cover it with a solution of caustic potassa; apply heat by means of a spirit lamp. After a little time, a gas, called phosphuretted hydrogen, which inflames as soon as it comes in

contact with the air, will pass over. Put the beak of the retort under water, and bubbles of gas will arise, which, on bursting, inflame. One part of the phosphorus takes hydrogen from the potassa, and thus produces the gas.

10. Heat a few grains of phosphorus in a test tube till it boils; and then a sulphur match dipped into it will be inflamed by the heat when exposed to the air.

11. We may here caution our readers never to mix phosphorus and sulphur, as it generally explodes when ignited.

12. Phosphoric acid may be procured as in 4, or by exposing phosphate of ammonia to a red heat in a crucible made of platinum. It is a deliquescent substance, and when in the flocculent state, as obtained by burning phosphorus under a dry bell glass, it dissolves in water with a hissing noise. It is inodorous, very acid, volatile at a red heat, though unchanged by it.

13. Phosphate of ammonia is a common ingredient in the bones of carnivorous animals.

14. Chloride of phosphorus consists of 11 phosphorus, 33·5 of chlorine, and is procured by distilling a mixture of phosphorus and corrosive sublimate.

15. Take a glass of water, pour a little muriatic acid into it, and then drop some phosphuret of lime into it. Phosphuretted hydrogen will immediately arise and present a miniature *Will-o'-the-Wisp.*

16. There are no definite compounds of phosphorus and nitrogen, though in some cases of animal decomposition the evolved nitrogen appears to hold phosphorus in solution.

17. By acting on fused phosphorus by voltaism, a small quantity of hydrogen is always emitted. It is also emitted from it as from sulphur, when it unites with some of the metals.

A salutary caution may be here introduced, namely, not to attempt any experiments which are not simple, because by that means a great many accidents will be prevented.

CHEMICÆ AMATOR.

ON CONTRIVING MACHINERY.

THE power of inventing mechanical contrivances, and of combining machinery, does not appear, if we may judge from the frequency of its occurrence, to be a difficult or a rare gift. Of the vast multitude of inventions which have been produced almost daily for a series of years, a large part has failed from the imperfect nature of the first trials; whilst a still larger portion, which had escaped the mechanical difficulties, failed only because the economy of their operations was not sufficiently attended to. The commissioners appointed to examine into the methods proposed for preventing the forgery of bank notes, state in their report, that out of one hundred and seventy-eight projects communicated to the Bank and to the commissioners, there were only twelve of superior skill, and nine which it was necessary more particularly to examine. It is, however, a curious circumstance, that although the power of combining machinery is so common, yet the more beautiful combinations are exceedingly rare. Those which command our admiration equally by the perfection of their effects and the simplicity of their means, are found only amongst the happiest productions of genius. To produce movements even of a complicated kind is not difficult. There exists a great multitude of known contrivances for all the more usual purposes, and if the exertion of moderate power is the end of the mechanism to be contrived, it is possible to construct the whole machine upon paper, and to judge of the proper strength to be given to each part as well as to the frame-work which supports it, and also of its ultimate effect, long before a single part of it has been executed. In fact, all the contrivance, and all the improvements, ought first to be represented in the drawings. On the other hand, there are effects dependent upon physical or chemical properties for the determination of which no drawings will be of any use. These are the legitimate objects of direct trials. For example:—if the ultimate result of an engine is to be that it shall impress letters on a copper-plate by means of steel punches forced into it, all the mechanism by which the punches and the copper are to be moved at stated intervals, and brought into contact, is within the province of drawing, and the machinery may be arranged entirely upon paper. But a doubt may reasonably spring up, whether the bur that will be raised round the letter which has been already punched upon the copper, may not interfere with the proper action of the punch for the letter which is to be punched next adjacent to it. It may also be feared that the effect of punching the second letter, if it be sufficiently near to the first, may distort the form of that first figure. If neither of these evils should arise, still the bur produced by the punching might be expected to interfere with the goodness of the impression produced by the copper-plate; and the plate itself, after having all but its edge covered with figures, might change its form, from the unequal condensation which it must suffer in this process, so as to render it very difficult to take impressions from it at all. It is impossible by any drawings to solve these difficulties, experiment alone can determine their effect. Such experiments having been made, it is found that if the sides of the steel punch are nearly at right angles to the face of the letter, the bur produced is very inconsiderable;—that at the depth which is sufficient for copper-plate printing, no distortion of the adjacent letters takes place, although those letters are placed very close to each other;—that the small bur which arises may easily be scraped off;—and that the copper-plate is not distorted by the condensation of the metal in punching, but is perfectly fit to print from, after it has undergone that process.

The next stage in the progress of an invention, after the drawings are finished and the preliminary experiments have been made, if any such should be requisite, is the execution of the machine itself. It can never be too strongly impressed upon the minds of those who are devising new machines, that to make the most perfect drawings of every part tends essentially both to the success of the trial, and to economy in arriving at the result. The actual execution from working drawings is comparatively an easy task; provided always that good tools are employed, and that methods of working are adopted, in which the perfection of the part constructed depends less on the personal skill of the workman, than upon the certainty of the method itself. The causes of failure in this stage most frequently derive their origin from errors in the preceding one; and it is sufficient merely to indicate a few of their sources. They frequently arise from having neglected to take into consideration that metals are not perfectly rigid but elastic. A steel cylinder of small diameter must not be regarded as an inflexible rod; but in order to ensure its perfect action as an axis, it must be supported at proper intervals. Again, the strength and stiffness of the framing which supports the mechanism must be carefully attended to. It should always be recollected, that the addition of superfluous matter to the immovable parts of a machine produces no additional momentum and therefore is not accompanied with the same evil that arises when the moving parts are increased in weight. The stiffness of the framing in a machine produces an important advantage. If the bearings of the axis, (those places at which they are supported) are once placed in a straight line, they will remain so, if the framing be immovable; whereas if the framework changes its form, though ever so slightly, considerable friction is immediately produced. This effect is so well understood in the districts where spinning factories are numerous, that, in estimating the expense of working a new factory, it is allowed that five per cent. on the power of the steam-engine will be saved if the building is fire-proof: for the greater strength and rigidity of a fire-proof building prevents the movement of the long shafts or axes which drive the machinery, from being impeded by the friction that would arise from the slightest deviation in any of the bearings.

In conducting experiments upon machinery, it is quite a mistake to suppose that any imperfect mechanical work is good enough for such a purpose. If the experiment is worth making, it ought to be tried with all the advantages of which the state of mechanical art admits; for an imperfect trial may cause an idea to be given up, which better workmanship might have proved to be practicable. On the other hand, when once the efficiency of a contrivance has been established, with good workmanship, it will be easy afterwards to ascertain the degree of perfection which will suffice for its due action. It is partly owing to *the imperfection of the original trials*, and partly to the gradual improvements in the art of making machinery, that many inventions which have been tried, and given up in one state of art, have at another period been eminently successful. The idea of printing by means of moveable types had probably suggested itself to the imagination of many persons conversant with impressions taken either from blocks or seals. We find amongst the instruments discovered in the remains of Pompeii and Herculaneum, stamps for words formed out of one piece of metal, and including several letters. The idea of separating these letters, and of re-combining them into other words, for the purpose of stamping a book, could scarcely have failed to occur to many: but it would almost certainly have been rejected by those best versed in the mechanical arts of that time; for the workmen of those days must have instantly perceived the impossibility of producing many thousand pieces of wood or metal, fitting so perfectly and ranging so uniformly, as the types or blocks of wood used in the art of printing. The principle of the press, which bears the name of Bramah, was known about a century and a half before the machine, to which it gave rise, existed; but the imperfect state of mechanical art in the time of the discoverer, would have effectually deterred him, if the application of it had occurred to his mind, from attempting to employ it in practice as an instrument for exerting force. These considerations prove the propriety of repeating, at the termination of intervals during which the art of making machinery has received any great improvement, the trials of methods which, although founded upon just principles, had previously failed. When the drawings have been properly made, and the machine has been well executed, and even when the work it produces possesses all the qualities which were anticipated, still the invention may fail; that is, *it may fail of being brought into general practice*. This will most frequently arise from the circumstance of its producing its work at a greater expense than that at which it can be made by other methods.

Whenever the new, or improved machine, is intended to become the basis of a manufacture, it is essentially requisite that the *whole* expense attending its operations should be fully considered before its construction is undertaken. It is almost always very difficult to make this estimate of the expense, the more complicated the mechanism, the less easy is the task; and in cases of great complexity and extent of machinery it is almost impossible. It has been estimated roughly, that the first individual of any newly-invented machine, will cost about five times as much as the construction of the second, an estimate which is, perhaps, sufficiently near the truth. If the second machine is to be precisely like the first, the same drawings, and the same patterns will answer for it; but if, as usually happens, some improvements have been suggested by the experience of the first, these must be more or less altered. When, however, two or three machines have been completed, and many more are wanted, they can usually be produced at much less than one-fifth of the expense of the original invention. The arts of contriving, of drawing, and of executing, do not usually reside in their greatest perfection in one individual; and, in this, as in other arts, *the division of labour* must be applied. The best advice which can be offered to a projector of any mechanical invention, is to employ a respectable draughtsman; who, if he has had a large experience in his profession, will assist in finding out whether the contrivance is new, and can then make working drawings of it. The first step, however, the ascertaining whether the contrivance has the merit of novelty, is most important; for it is a maxim equally just in all the arts, and in every science, that *the man who aspires to fortune or to fame by new discoveries, must be content to examine with care the knowledge of his contemporaries, or to exhaust his efforts in inventing again, what he will most probably find has been better executed before.* This, nevertheless, is a subject upon which even ingenious men are often singularly negligent. There is, perhaps, no trade or profession existing in which there is so much quackery, so much ignorance of the scientific principles, and of the history of their own art, with respect to its resources and extent, as are to be met with amongst mechanical projectors. The self-constituted engineer, dazzled with the beauty of some, perhaps, really original contrivance, assumes his new profession with as little suspicion that previous instruction, that thought and painful labour, are necessary to its successful exercise, as does the statesman or the senator. Much of this false confidence arises from the improper estimate which is entertained of the difficulty of invention in mechanics. It is, therefore, of great importance to the individuals and to the families of those who are too often led away from more suitable pursuits, the dupes of their own ingenuity and of the popular voice, to convince both them and the public that the power of making new mechanical combinations is a possession common to a multitude of minds, and that the talents which it requires are by no means of the highest order. It is still more important that they should be impressed with the conviction that the great merit, and the great success of those who have attained to eminence in such matters, was almost entirely due to the unremitted perseverance with which they concentrated upon their successful inventions the skill and knowledge which years of study had matured.

TOBACCO.

It is said that the name tobacco was given by the Spaniards to the plant, because it was first observed by them at Tabasco, or Tabaco, a province of Yucatan in Mexico. In 1560, Nicot, the French ambassador to Portugal, having received some tobacco from a Flemish merchant, showed it, on his arrival in Lisbon, to the grand prior, and, on his return into France, to Catherine of Medicis, whence it has been called Nicotiana by the botanists. Admiral Sir Francis Drake having, on his way home from the Spanish Main, in 1586, touched at Virginia, and brought away some forlorn colonists, is reported to have first imported tobacco into England. But, according to Lobel, this plant was cultivated in Britain before the year 1570; and was consumed by smoking in pipes by Sir Walter Raleigh, and companions, so early as the year 1584.

The plants are hung up to dry during four or five weeks; taken down out of the sheds in damp weather, for in dry they would be apt to crumble into pieces; stratified in heaps, covered up, and left to sweat for a week or two, according to their quality and the state of the season; during which time they must be examined frequently, opened up, and turned over, lest they become too hot, take fire, or run into putrefactive fermentation. This process needs to be conducted by skilful and attentive operatives. An experienced negro can form a sufficiently accurate judgment of the temperature, by thrusting his hand down into the heap.

The tobacco thus prepared, or often without fermentation, is sent into the market; but, before being sold, it must undergo the inspection of officers, appointed by the state with very liberal salaries, who determine its quality, and brand an appropriate stamp upon its casks, if it be sound; but if it be bad, it is burned.

Our respectable tobacconists are very careful to separate all the damaged leaves, before they proceed to their preparation, which they do by spreading them in a heap upon a stone pavement, watering each layer in succession, with a solution of sea salt, of specific gravity 1·107, called *sauce*, till a ton or more be laid; and leaving their principles to re-act on each other for three or four days, according to the temperature and the nature of the tobacco. It is highly probable that ammonia is the volatilizing agent of many odours, and especially of those of tobacco and musk. If a fresh green leaf of tobacco be crushed between the fingers, it emits merely the herbaceous smell common to many plants; but if it be triturated in a mortar, along with a little quicklime or caustic potash, it will immediately exhale the peculiar odour of snuff. Now analysis shows the presence of muriate of ammonia in this plant, and fermentation serves further to generate free ammonia in it; whence, by means of this process, and lime, the odoriferous vehicle is abundantly developed. If, on the other hand, the excess of alkaline matter in the tobacco of the shops be saturated by a mild dry acid, as the tartaric, its peculiar aroma will entirely disappear.

Tobacco contains a great quantity of an azotized principle, which by fermentation produces abundance of ammonia; the first portions of which saturate the acid juices of the plant, and the rest serve to volatilize its odorous principles. The salt water is useful chiefly in moderating the fermentation, and preventing it from passing into the putrefactive stage; just as salt is sometimes added to saccharine worts in tropical countries, to temper the fermentative action. The sea salt, or concentrated sea water, which contains some muriate of lime, tends to keep the tobacco moist, and is therefore preferable to pure chloride of sodium for this purpose. Some tobacconists mix molasses with the salt *sauce*, and ascribe to this addition the violet color of the *macouba* snuff of Martinique; and others add a solution of extract of liquorice. The following prescription is that used by a skilful manufacturer:—In a solution of the liquorice juice, a few figs are to be boiled for a couple of hours; to the decoction, while hot, a few bruised anise-seeds are to be added, and when cold, common salt to saturation. A little spirit of wine being poured in, the mixture is to be equalby, but sparingly, sprinkled with the rose of a watering-pot, over the leaves of the tobacco, as they are successively stratified upon the preparation floor.

The fermented leaves, being next stripped of their middle ribs by the hands of children, are sorted anew, and the large ones are set apart for making cigars. Most of the tobaccos on sale in our shops are mixtures of different growths: one kind of smoking tobacco, for example, consists of 70 parts of Maryland, and 30 of meagre Virginia; and one kind of snuff consists of 80 parts of Virginia, and 30 parts of either Humesfort or Warwick. The Maryland is a very light tobacco, in thin yellow leaves; that of Virginia is in large brown leaves, unctuous or somewhat gluey on the surface, having a smell somewhat like the figs of Malaga; that of Havannah is in brownish, light leaves, of an agreeable and rather spicy smell; it forms the best cigars. The Carolina tobacco is less unctuous than the Virginian; but in the United States it ranks next to the Maryland. The shag tobacco is dried to the proper point upon sheets of copper. Tobacco is cut into what is called shag tobacco by knife-edged chopping stamps.

Mr. L. W. Wright obtained a patent in August, 1827, for a tobacco-cutting machine, which bears a close resemblance to the well-known machines with revolving knives, for cutting straw into chaff. The tobacco, after being squeezed into cakes, is placed upon a smooth bed within a horizontal trough, and pressed by a follower and screws to keep it compact. These cakes are progressively advanced upon the bed, or fed in, to meet the revolving blades. The speed of the feeding-screw determines the degree of fineness of the sections or particles into which the tobacco is cut.

Dr. Ure was employed some years ago by the Excise, to analyze a quantity of snuff, seized on suspicion of having been adulterated by the manufacturer. He found it to be largely drugged with pearl-ashes, and to be thereby rendered very pungent, and absorbent of moisture; an economical method of rendering an effete article at the same time active and aqueous.

According to the recent analysis of Possett and Reimann, 10,000 parts of tobacco-leaves contain 6 of the peculiar chemical principle *nicotine*; 1 of *nicotianine;* 287 of slightly bitter extractive; 174 of gum, mixed with a little malic acid; 26·7 of a green resin; 26 of vegetable albumen; 104·8 of a substance analogous to gluten; 51 of malic acid; 12 of malate of ammonia; 4·8 of sulphate of potassa; 6·3 of chloride of potassium; 9·5 of potassa, which had been combined with malic and nitric acids; 16·6 of phosphate of lime; 24·2 of lime, which had been combined with malic acid; 8·8 of silica; 496·9 of fibrous or ligneous matter; traces of starch; and 88·28 of water.

Nicotine is a transparent colorless liquid, of an alkaline nature. It may be distilled in a retort plunged into a bath heated to 290° Fahrenheit. It has a pricking, burning taste, which is very durable; and a pungent disagreeable smell. It burns by means of a wick, with the diffusion of a vivid light, and much smoke. It may be mixed with water in all proportions. It is soluble also in acetic acid, oil of almonds, alcohol, and ether, but not in oil of turpentine. It acts upon the animal economy with extreme violence; and in the dose of one drop it kills a dog. It forms salts with the acids. About 1 part of it may be obtained by very skilful treatment from 1000 of good tobacco.

PRINCE RUPERT'S DROPS.

(*To the Editor*)

SIR.—Having read in your valuable Magazine, two articles respecting Rupert's drops, which I think very erroneous, I have ventured to write to you on the subject. Your correspondent in page 182, states, that if Rupert's drops be thrown down forcibly upon flags, they will recoil and not break. Now after reading this statement, I made a dozen and tried them in the manner described, when only three out of the dozen recoiled; and those three in being brought a second time in contact with the flags went to shivers.

Page 239, article "Phenomena of Glass," reads thus:—The glass in a melted state, when dropped into cold water, by its great heat decomposes it, and at the same time immediately contracting it, forms into a drop, inclosing a mixture of oxygen and hydrogen, derived from the water. Now, in making Rupert's drops, the metal or melted glass never alters its form from being dropped off the iron rod; nor can it inclose a mixture of oxygen and hydrogen, when the water does not attract the surface of the glass; but if melted glass be dropped into water in any other form than that of Rupert's drops, the surface is instantly attracted by the water, and is fractured all over, so that you may reduce it to powder with your fingers; and even Rupert's drops, if they be either too hot or too cold when dropped into the water. If they contained oxygen and hydrogen, would not heating them to a melting state ignite the gas and cause them to explode? I have melted them at the flame of a candle, and at the blow-pipe jet, and drawn them in two without any explosion, and yet they broke in the usual way afterwards.

My idea is, that the drops by being so quickly congealed, causes a number of minute fractures inside, and as soon as the end is broken off, the air rushes in with such force as to break it to pieces, and at the same time imparting a shock to the hand.

THOMAS BOWES.

Port Dundas, near Glasgow.

MEMORANDA.

Lunatics.—Of the influence of the planets and the moon—notwithstanding the name of lunatics, and the vulgar impressions—no proof whatever exists. Yet physicians of eminence—Mead even—have said, "the ravings of mad people kept lunar periods, accompanied by epileptic fits." The moon apparently is equally innocent of the thousand things ascribed to her. When the paroxysms of mad people do occur at the full of the moon, Dr. Burrowes inclines to explain the matter thus:—"Maniacs are in general light sleepers; therefore, like the dog which bays the moon, and many other animals, remarked as being always uneasy when it is at the full, they are disturbed by the flitting shadows of clouds which are reflected on the earth and surrounding objects. Thus the lunatic converts shadows into images of terror, and, equally with all 'whom reason lights not,' is filled with alarm, and becomes distressed and noisy."

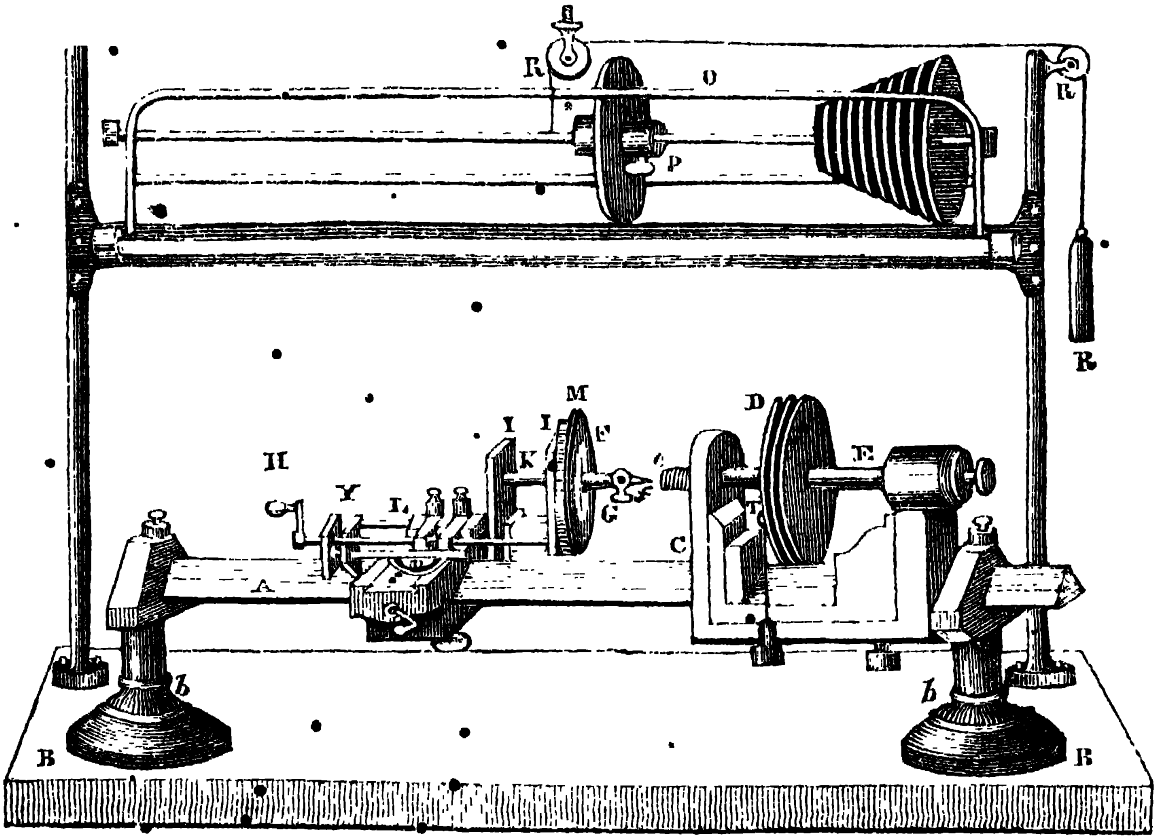
West Indian Coal.—The coal raised from the mine discovered a year ago, about six miles from Havana, has been tried by the Spanish steam-frigates, and pronounced by the engineers to be excellent in quality—superior to the best English. Analysis shows the coal to consist of the following parts:—Carbon, 71·74; oxygen, 6·32; hydrogen, 8·44; 13· ashes 50—100·00. The railroad from the port to the mine is in rapid progress towards completion. As the bed is believed to be very extensive, the enterprising proprietors anticipate handsome profits on their outlay whenever the West India steamers shall regularly call at Havana for a supply of fuel.

Derbyshire Diamonds.—Perhaps it may not be generally known that the Peak of Derbyshire produces what are termed Derbyshire diamonds; they are small detached and perfect crystals of colorless quartz, of an hexagonical prism terminated pyramids, and others of a lighter color; they are often found at Bakewell, Brassington Common, Buxton, Castleton, and Darley Dale, and are greatly inquired after, and much used by the lapidaries of Birmingham, Derby, &c.—*Sheffield Iris.*

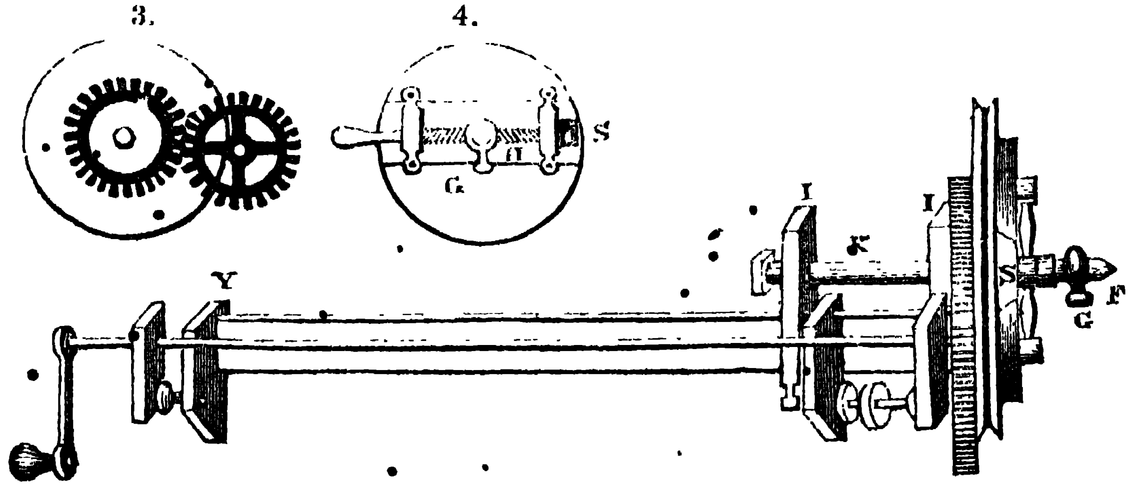
Fire and Water Proof Cement.—Pour a pint of vinegar into a pint of milk; when the latter has fully coagulated, clear it off the lumps, and let it settle, then mix the whole well together; now sift into the liquid quicklime, till upon stirring the whole we obtain a thick paste. This cement will permanently unite marble, earthenware, china, &c. —*French Paper.*

Destruction of a City by an Earthquake.—By a letter received from Central America by the last Jamaica packet, it appears that the entire city of Cartago, containing a population of 10,000 persons, was destroyed by an earthquake early in the morning of September 2d, though, as nearly all the buildings, are very low and composed of wood, and as the inhabitants had previously risen, but few (not more than forty or fifty persons) were killed or wounded. This earthquake occurred without previous warning, and was connected with an eruption of the well-known volcano about three leagues distant. A smart shock of the same earthquake was at the same time felt in the town of San Jose, not far distant, at which place the earth trembled for several days subsequently, but not much damage was done there.

Fig. 1.



WIGHTMAN'S LATHE.



W. E. WIGHTMAN'S LATHE.

THE following account of this instrument is thus described by himself in Hebert's "Engineer's Encyclopædia," page 822. "Feeling assured that it may prove of the most eminent service to mechanics, as the arrangements are extremely simple and easily understood, and the construction such as any tolerable workman can accomplish, and avail himself of the advantages it offers, at a moderate cost.

"Fig. 1 represents the lathe, with the cutter-frame fixed in the compound sliding rest, ready for use. A, the triangular bar on which the machine is mounted. B B, two pillars which support the bar; the parts *b b* fix it to the lathe-frame. C, the head; D, the pulley; E, the mandril; *e*, the screw on which the chucks are fixed; F, the cutter-frame; *f*, the cutter; G, two wheels, which give a slow motion to the cutter-frame; H, the rod and handle of the slow motion; I I, two heads or puppets, in which is fixed the spindle K of the cutter-frame; L, a bar of steel, on which the puppets are fixed, and which also fastens the cutter-frame to the compound sliding rest, by passing it through a hole in the tool-frame, as will be seen on reference to the figure, the part Y removing for the purpose; M, a groove turned on the edge of the cutter-frame, for a string to work on; O represents the frame, or over-head motion for double stringing the lathe; P, a moveable pulley, whereby it may be fixed perpendicularly over the cutter-frame; R R R, the pulley's string and weight connected with the frame O, for double stringing the lathe; T, the index to the division-plate; S, one of the two screws for changing the rectangular position of the compound sliding-rest to an oblique. S, Figs. 2 and 3, represents the slide of the cutter-frame; and H, Fig. 3, the screw, whereby the slide is moved; G, the screw for fastening the cutter. Fig. 2, is an enlarged view of the cutter-frame, when removed from the rest. Fig. 3, represents the face of the cutter-frame; Fig. 4, the back of it, with the wheels of the hand-motion. The letters refer to the same parts in all the figures.

"This machinery is intended to supersede the use of the eccentric chuck, by assuming a more natural and easy method of engraving, by the tool or cutter tracing the work, instead of the article doing it that is to be ornamented. By this improvement, the action of the tool is more distinctly seen than could be, by the movement of the chuck, especially after a few circles have been cut; for, by their rotation, the eye (particularly of an amateur) is soon fatigued, and yet to these inconveniences a turner must continue to submit, if no better method could be contrived.

"The principal advantages of the present invention are the following:—At a comparatively trifling expense. (to the costly machinery now in use,) a turner may be put in possession of an apparatus, which will answer all the purposes of eccentric and cycloidal turning, and which will, at the same time, form a complete drilling frame. As an apparatus intended to supersede the use of the eccentric chuck, it combines many advantages, amongst which, three may be mentioned that are of importance:—1st. As all patterns are worked by the divisions of the plate on the small wheel of the lathe, a much more extensive variety of circles can be obtained, than could be by the divisions of the eccentric chuck. 2d By slackening the screws S S, in the large slide of the compound sliding-rest, a change may be effected from the rectangular position of the cutter-frame to an oblique position; and, after the proper angle is obtained, (the screws being tightened,) the segments of circles can be worked round a centre with greater accuracy than could be by tracing over patterns, which I believe is the common method; while the alteration of my machinery, for such purpose, would scarcely occupy a minute of time; an object which is of no small importance for the dispatch of business. 3d. The loss of time in centering the work, occasioned by the necessity of removing it from one chuck to another, to receive the different ornaments, (an evil severely felt by turners,) is obviated by my improvement; as also the great difficulty, so often experienced in getting the *face* of the work to run true again, after taking it from one chuck to another; from their liability to get out of truth by the wearing of the screws in fixing them to, and removing them from the spindle of the lathe; in which case every effort at fine-finishing would be inevitably defeated.

"To apply my apparatus for cycloidal turning, the addition of a rod is required to connect the cutter-frame with the universal chuck, after it is screwed on the spindle of the lathe; but which, on account of its connexion, (being a bad draughtsman,) I am unable to send. The following description will, I hope, make its construction appear sufficiently intelligible:—The edge of the plate of the universal chuck, (the machine on which the work to be turned and ornamented is fixed, and which is a common appendage to all lathes,) I have divided into 111 equal parts, which form a wheel; and upon the face of the left-hand head of the lathe is fixed a plate, and a corresponding one on the side of the rest, through which the axis of the rod connecting the chuck and cutter-frame revolves. Now, if upon the rod is fixed a wheel of twelve teeth, working on the wheel formed by the edge of the universal chuck; and if upon the other end of the rod is fixed a wheel of the same size and number as those which work the cutter-frame, and to work in one of those wheels; then it must be obvious, that, by the chuck revolving once, the wheel of twelve would make twelve revolutions, which number would be given to the cutter-frame, thereby tracing an accurate circle of twelve cycloids. Again, by changing the wheel of twelve to another of proper proportions of 144, a number of cycloids would be described equal to that proportion. Then, by sliding the connecting-rod out of gear, and moving the universal chuck any number of teeth forward or backward, the cycloids would beautifully intersect each other

"It may, perhaps, be unnecessary to add, that this, and the eccentric apparatus, must be worked by the hand-motion of the cutter-frame.

"To change it into a drilling frame, all that is required, consists in throwing all the wheels out of gear, and passing a string over the groove in the cutter-frame, to work on the pulley P, which is fixed on the same arbor as the pulley used in double stringing a lathe. Then pass a string, (which should be kept for the purpose,) over the last-mentioned pulley, and under the large, or fly-wheel of the lathe; and after the drill has been fixed in the socket of the cutter-frame, and adjusted to run true, or central, the machine will be ready for work. Now it must be clear that, by working the treadle of the lathe, as in turning, a rotatory motion would be given to the cutter-frame; and after the tool has been advanced to the work, then, by moving the large or right angle slide of the rest, a straight line would be drilled, of a length in proportion to the movement of the slide. Then change the division of the plate on the small wheel of the lathe, and if the first line was cut *from* the centre, then cut the next *to* the centre, and so on till the whole is completed, when a beautiful circle of straight lines would be cut from a centre."

OBSERVATIONS ON IGNIS FATUUS.

BY R. CHAMBERS, ESQ., F.L.S. F.Z.S.

(In a paper read before the Linnæan Society.)

It has been the opinion of many naturalists, that the luminous appearance known by the names of Ignis Fatuus, Will-with-the-wisp, and Jack-o'-lantern, is not a meteor, as generally supposed, but a luminous insect; and, in confirmation of this hypothesis, I have collected, not merely the opinions, but the experience, of many persons who have had repeated opportunities of observing this singular phenomenon.

In the year 1814, I had a conversation on this subject with my esteemed friend, the late Mr. James Dickson, the celebrated botanist, who informed me that he felt confident the Ignis Fatuus was not a meteor, but a luminous insect, for he had seen it settle on a plant and fly off again. The same, he stated, had been witnessed by his friend Mr. Curtis, author of the *Flora Londinensis.* My curiosity being greatly excited by these remarks, I went immediately to my father, the late Mr. Anthony Chambers, who, having lived for many years in the neighbourhood of Lincoln, where the Ignes Fatui are frequently seen, was likely to afford me information on the subject. He told me that, when a lad, returning in the dusk of the evening through Bultham Wood, he observed behind him a Jack-o'-lantern, which followed him through the wood; and when this luminous appearance came to the gate, at the end of the path, it rose to clear the upper bar, and flew into the adjoining meadow. At another time, he observed, in the same neighbourhood, two of these Will-with-the-wisps flying about each other, apparently at play, which they did for a considerable time, and at last settled on a furze bush.

These remarks corroborated the opinion of Messrs. Dickson and Curtis; and, on referring to the *Transactions of the Royal Society*, vol. v., there is a communication on the same subject by Derham, who says,—"It being the opinion of divers skilful naturalists, particularly Mr. Francis Willughby and Mr. Ray, that the Ignes Fatui are only the shining of a great number of the male glow-worms, in England, or of the Pyraustæ in Italy, flying together. My own observations I made at a place that lay in a valley between rocky hills, which, I suspect, might contain minerals, in some boggy ground near the bottom of those hills. When seeing one in a calm dead night, with gentle approaches I got up by degrees, within two or three yards of it, and viewed it with all the care I possibly could. I found it frisking about a dead thistle, growing in the field, until a small motion of the air (even such as was caused by the approximation of myself) made it skip to another place, and thence to another and another." It is generally allowed that the male glow-worm is slightly luminous, yet not sufficiently so to put on the appearance mentioned by Derham. The following remarks by Mr. Arthur Aikin, in his *Tour through Wales,* will somewhat elucidate the subject:—"I was not a little surprised to see the glow-worms, at our approach, darting over the hedges into the fields. Knowing the female alone to be luminous, and, at the same time, destitute of wings, this phenomenon puzzled me a good deal; nor can I account for it, except upon the supposition of the male bearing the female through the air when in the act of their amours." Wishing to obtain all the information I could on a subject so interesting, I spoke of it to my kind and intelligent friend, Thomas Stothard, Esq., R.A., who, besides possessing talents of the highest order in every department of art, is an excellent practical entomologist. From this gentleman I received the following letter:—

June 16, 1823 Newman Street.

"My good Sir,—Agreeably to your request, I send you the best account my recollection will supply of the Ignis Fatuus we conversed about when last together. As I was returning from Plymouth early in June, 1821, having travelled all the preceding day and night, and had passed Blandford early in the morning, considerably before sunrise, when objects were just distinguishable, I saw what was new to me, and which fixed all my attention, for the short time allowed to observe it while mounted on the outside of the coach, passing at the usual rate of 7 or 8 miles an hour. On my right hand, and the side on which I was placed, at the distance of 40 or 50 paces, appeared an irregular light, bounding or rising to the height of 3 or 4 ft. over some heathy shrubs, which covered the high and marshy ground spreading to a great extent: amongst these it sank and reappeared with a motion somewhat between flying and leaping. A friend, who was with me, observed it, and exclaimed that it was the third appearance of the like phenomenon; and, requesting him to give me more information, he answered, that, when travelling the Bath road on a similar conveyance, at the same time in the morning and season of the year, he observed one, though not so distant from the road as the one we had passed: its flight was in the same direction with the coach; and several times it alighted on the shrubs or high grass on the border of a wet ditch near the road side. The experienced coachman pronounced it to be a Will-with-the-wisp.

"Yours, dear Sir, very truly,
"T. STOTHARD."

Mr. Stothard was of opinion that the supposed Ignis Fatuus, from its motion between flying and leaping, is the mole-cricket. He brought one from his cabinet, and pointed to the structure of its wings, in proof of this conclusion; for it could not fly high, nor long together; and the habitat of the Gryllotálpa being the same as where this luminous appearance is usually seen, is another coincidence. In the second volume of Mr. Kirby's *Introduction to Entomology*, he relates a circumstance corroborative of the above hypothesis:—"The Rev. Dr. Sutton, of Norwich, when he was curate of Tikleton, Cambridgeshire, in 1780, a farmer of that place of the name of Simpringham brought to him a mole-cricket, and told him that one of his people, seeing a Jack-o'-lantern, pursued and knocked it down, when it proved to be this insect, and the identical specimen shown to him."

In the admirable work just noticed, its learned author, who strongly advocates the opinion of these supposed meteoric appearances being luminous insects, gives the following interesting fact:—"Mr.

Sheppard, travelling one night, between Stamford and Grantham, on the top of the stage, observed for more than ten minutes a very large Ignis Fatuus in the low marshy grounds, which had every appearance of being an insect. The wind was very high; consequently, had it been a vapor, it must have been carried foward in a direct line; but this was not the case. It had the same motions as a tipula, flying upwards and downwards, backwards and forwards; sometimes appearing as settled, and sometimes as hovering in the air."

In the summer of 1826, I went into the fens of Lincolnshire, hoping to see an Ignis Fatuus; but in this I was disappointed. From Joseph Simpson, an intelligent fisherman at Frieston Shore, near Boston, I obtained the following information:—That, before the fens were drained, his father had seen a dozen Ignes Fatui, apparently playing with each other like insects, the highest not more than eight or ten feet above the ground. He told me that, since the draining of the fens, they were not so common; yet he and several others had seen one settle on a hedge, and on a post, and fly off again; and that it appeared to him to have a voluntary motion, for he noticed one flying towards a hedge, then rise and pass over it.

My friend Mr. Cole, surgeon, of Charlotte Street, Bedford Square, has favored me with the following particulars on this interesting but obscure subject:—

"In October, 1823, I went to Worcester, and was met by a young man, in the service of my father, who came there with a gig to drive me to Leigh, near Malvern. Having heard that he had seen a Will-with-the-wisp, I took the opportunity the drive afforded, to inquire about what he had seen, when he stated as follows:—'I was coming home with the boy from looking after the sheep, at the further side of the farm. Our path lay near a hedge; and on a sudden there appeared at a distance a ball of fire about as big as my head. We stopped; and it came directly towards us. The boy asked me what it was: I told him I supposed it must be what they called a Jack-o'-lantern. It had a dancing kind of motion, and advanced under the hedge side, till it came quite near to us; it then divided into a dozen or twenty parts, forming so many balls of fire, about the size of my fist, which flew apart from each other, and played about for a short time. They then joined together again into one large ball, as at first, and turned over the hedge into the next field. It passed between two oak trees that stood at some distance from the hedge, and then went straight across the fields, rising over the hedges, until it disappeared in the distance.' In reply to my questions, he stated that it was in the spring of the year, and that the night was about as dark as it was at the time he was speaking, a clear moonless night in the beginning of October, about ten o'clock. To an inquiry whether he thought the motion of the object he saw, especially when it divided, and played about, and then united again, was like anything he had seen before, he replied that he did not know; but, when afterwards asked if he thought it like the playing of flies or gnats in the sun, he said it was precisely similar. The spot where he saw it was shown to me. The soil is dry, and the situation is slightly elevated above the surrounding country: there is no marshy or swampy ground in the neighbourhood. The man's name is William Day. He was brought up in my father's family, and resides there still."

I have questioned many persons who have seen the Ignis Fatuus, besides those whom I have mentioned, and they invariably concur in its having a voluntary motion, flying backwards and forwards, rising to clear hedges, resting on gates, pales, and other objects that lie in its route. From the facts I have been able to collect, I think we may infer that many more insects are luminous than naturalists have imagined; and, should these observations not be sufficient to convince naturalists that the supposed Ignes Fatui are really and truly insects, yet I anxiously hope that the remarks I have made may be the means of leading gentlemen, who reside in favorable situations, to investigate this curious phenomenon.

[There undoubtedly appear considerable grounds for supposing that the history of many cases of Ignes Fatui may be connected with the light emitted by certain insects; but, at the same time, there is strong evidence opposed to the universal adoption of this explanation. For observations on this subject, see Jameson's *Edinburgh Journal* for January, 1833, and *Entomological Magazine*, vol. i., p. 350.—ED.]

WATER-PROOF CLOTH.

(In answer to a Correspondent.)

A PATENT was obtained, in August, 1830, by Mr. Thomas Hancock, for rendering textile fabrics impervious to water and air, by spreading the liquid juice of the caoutchouc tree upon the surfaces of the goods, and then exposing them to the air to dry. It does not appear that this project has been realised in our manufactures.

Mr. William Simpson Potter proposes, in his patent, of April, 1835, to render fabrics water-proof by imbuing them with a solution of isinglass. alum, and soap, by means of a brush applied to the wrong side of the cloth, distended upon a table. After it is dry, it must be brushed on the wrong side, against the grain. Then the brush is to be dipped in clean water, and passed lightly over the cloth. The gloss caused by the above application can be taken off by brushing the goods when they are dry. Cloth so prepared is said to be impervious to water, but not to air.

Mr. Sievier s plan of rendering cloth water-proof, for which he obtained a patent in December, 1835, consists in spreading over it, with a brush, a solution of India-rubber in spirits of turpentine, at one or more applications, and then applying a similar solution mixed with acetate of lead, litharge, sulphate of zinc, gum mastic, or other drying material. He next takes wool, or other textile material, cut into proper lengths, and spreads it upon the surface of the fabric varnished in this manner, for the purpose of forming the nap or pile. He then presses the cloth by means of rollers, or brushes. so as to fix the nap firmly to its surface.

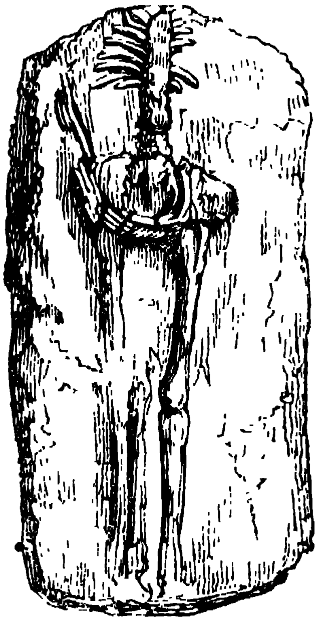
ON THE DATE OF MAN'S EXISTENCE ON THE SURFACE OF THE GLOBE.

WHILE the researches of geologists accumulate proofs of the antiquity of our planet, and of a long series of revolutions, by which its surface has become modified; while they teach us, by appealing to the silent language of their reliquia, that races of organic beings have tenanted the globe, previously to the existence of our continents and islands, at a time when its surface exhibited a condition, of which we can form only a plausible conjecture, but of which these relics are the faithful records; while they convince us that successive eras have taken place, and, on the fragments recovered from the buried Herculaneum of Nature, enable us to decipher the hieroglyphics which announce the progress of creation,—they assure us that Man is but of recent date, the ultimate of animals called into life and being. It would appear to be now well established, that, in none of the older strata, in none of what are termed secondary formations, in none of the tertiary formations, in none of the regular strata of the globe, do the fossil relics of Man occur. In the beds, which contain the remains of ancient races, the types of forms blotted out of creation,—even in the deposits containing the bones of Elephants and Rhinoceroses, which have now their living representatives, we search in vain for the fossil remains of our species. Once, indeed, the huge bones of extinct animals were regarded as human, and philosophers speculated upon the stature of a race more mighty than the Anakim, of which these were deemed the relics,—an error, at which we now smile. "Many of the labourers," says Cuvier, "in the gypsum quarries about Paris, believe, that the bones, which occur so abundantly in them, are, in a great measure, human; but I have seen thousands of these bones, and I may safely affirm, that not one of them has ever belonged to our species. I have examined, at Pavia, the groups of bones brought, by Spallanzani, from the island of Cerigo; and, notwithstanding the assertion of that celebrated observer, I affirm, also, that there is not one among them that could be shown to be human."

It is not; however, affirmed, or pretended, that no fossil relics of Man have been found, or may be found,—for the existence of such is ascertained; but they do not occur in such formations, or under such conditions, as indicate his contemporary existence with the Palæotheria, the Anaplotheria, or the Dinotheria,—the Mammoths and the Mastodons; and their situation is such as to corroborate the deduction, from other proofs, that Man is a new, and, geologically speaking, a recent denizen of the surface of our planet.

The most remarkable fossil remains of our species are those which occur in a tufaceous deposit, of modern date, and daily increasing, in the island of Guadaloupe: a fine specimen of an almost entire skeleton, imbedded in his calcareous matrix, is in the British Museum; another (see Fig.) is in the Museum of Paris. In both, the skull is wanting.

These fossil skeletons of Guadaloupe, as Cuvier observes, all more or less mutilated, are found near Porte de Moule, on the north-west coast of the mainland of Guadaloupe, in a kind of slope, resting against the steep edges of the Island. This slope is, in a great measure, covered by the sea at high water, and is found to be nothing else than a tufa, formed, and daily augmented, by the very small debris of shells and corals, which the waves are perpetually detaching from the rocks, the accumulated mass of which assumes a great degree of cohesion in the places that are most frequently left dry. It is found, on examining them with a lens, that several of these fragments have the same red tint as a part of the corals contained in the reefs of the island. Formations of this kind are common in the whole archipelago of the Antilles, where they are known to Negroes under the name of Maçonne-bondieu. Their augmentation is proportioned to the violence of the surge; and they have greatly extended the plain of Cayes, in St. Domingo, in which sometimes are found fragments of earthen vessels, and of other articles of human fabrication, at a depth of twenty feet. Various conjectures have been made, and even events have been imagined, in order to account for the deposition of these skeletons of Guadaloupe. But, from all the circumstances of the case, M. Jounés, correspondent of the Academy of Sciences, who has been on the spot, and to whom Cuvier is indebted for numerous details, thinks, that they are merely bodies of persons who have perished from shipwreck. Their discovery occurred in 1805. In the rock, which inurns these bones, M. Kœnig detected fragments of Millepora miniacea, of several Madrepores, as well as the fragments of shells, which he compares to Helix acuta, and Turbo pica; and Cuvier states that, in the specimen at Paris, which was sent there by General Donzelot, there are embedded shells of the neighbouring sea, and land shells, which are still found alive in the island; namely, the Bulimus Guadaloupensis of Ferussac. Sir Humphry Davy subjected small portions of the skeleton in the British Museum to chemical analysis, and found that the bones contained part of their animal matter, and all their phosphate of lime.



Independently, however, of the existence of fossil reliquia of man at Guadaloupe, human bones, but scarcely to be termed fossilized, have been found in other places. They not unfrequently occur in caverns, or fissures of rocks, mixed with articles of human fabrication: they are sometimes found in such places, buried in fine mud, beneath a layer of stalagmite, and sometimes incrusted in the latter. In these caves and fissures, where the wandering savages of a thinly peopled country might occasionally find refuge, or into which they might have been accidentally precipitated, are found the remains of many extinct Mammalia; viz., of extinct species of bears, of hyænas, lions, or large feline animals; deer, elephants, hippopotamuses, &c.; as well as of animals now extant—horses, oxen, sheep, dogs, wolves, and foxes.

Thus, in the cave of Gaylenreuth, there occurred, according to Rosenmüller, the bones of men, horses, oxen, sheep, deer, roes, mules, badgers, dogs, and foxes, besides the bones of bears, hyænas, and tigers; but, from the researches made by him, in the cave itself, and from the state of preservation in which the bones of the former animals were found, it was evident that they must have been deposited at periods much more recent than those of the latter. In some of the grottoes of the cave of Klanstein, M. Rosenmüller, found two human skeletons, superficially placed, and incrusted with stalactite,—a proof of their modern deposition. In the celebrated cave of Kirkdale, in Yorkshire, in which bones of the elephant, hippopotamus, tiger, hyæna, wolf, &c., occurred in abundance, many of them bearing the marks of the teeth of the animals that had gnawed them, and intermixed with the excrements of the hyæna, no human bones have been discovered; but, in the caves of Paveland, in the county of Glamorgan, at the entrance of the English Channel, the clergyman and surgeon of the neighbouring village of Portinan, found the skeleton of a woman, together with bones of the elephant, rhinoceros, horse, bear, hyæna, fox, rat, and, also, of birds. Many of these bones, however, were modern; and the diggings, made at remote and unknown periods, had displaced the ancient bones, and not only mixed them with the modern, but also with shells of the present sea. It is to be regretted that, upon the discovery of caves containing bones, persons, anxious to examine them, yet little aware of the importance of leaving them undisturbed in their respective situations, for the investigation of the geologist, begin to dig, and collect, mixing them together, so as to prevent the possibility of ascertaining their respective order of deposition. In the celebrated cavern of Adelsberg, in Carniola, the Chevalier de Lowengreif discovered, in 1816, a hole in one of its walls, at the height of fourteen fathoms: this conducted him to a series of new caves, of vast extent, and of incomparable beauty, from the lustre and variety of their stalactites. A part of these caves, however, it is proved, must have been formerly known, and either are, or have been, accessible by some other entrance; for inscriptions were found in them, with dates from 1393 to 1676, together with human bones and entire carcasses that had been buried there. Through these caves, M. Volpi (Director of the School of Commerce and Navigation, at Trieste) asserts his having proceeded for more than three leagues, almost in a straight line, and that he was stopped only by a lake, which rendered it impossible to go on. It was about two leagues from the entrance that he discovered bones of animals, which he describes under the name of Palæotheria, but which belonged to the extinct bears, whose remains occur in the bear-caves of Germany. The remains of Man, therefore, found in the caves, which contain, with the bones of recent animals, those of extinct species, prove nothing in favor of the contemporary existence of the latter and the human race; any more than the circumstance of finding the coins of the present century with those of the Saxon era, or of ancient Rome, at the bottom of a pit, or lake, would prove a coincidence of time in their fabrication. One thing, however, is clear, that, at the period when our Continent had assumed its present general form, it was the abode of species of Mammalia which have passed away, and whose representatives now live only in the hotter regions of the globe. The circumstances attendant upon their deposition in these caves, where they are often found in recesses, the entrance to which could not have admitted the living animal, involve many speculations: but the subject is alien to our present purpose; nor do we profess to be able to throw more light upon it than has been done by our learned and zealous geologists.

We may here allude to the fossil human relics found near Kösritz, and said to have been discovered consolidated in the limestone rock, together with the remains of the rhinoceros, lion, hyæna, &c. M. de Sclotheim, by whose these organic remains were discovered, throws a doubt upon this point, and considers the human bones to have been deposited at a later epoch than the bones of the animals referred to, and in this opinion he is borne out by Dr. Buckland, who observes that "the case of Kösritz affords no exception to the general fact, that human bones have not been discovered in any of those diluvial deposits which have hitherto been examined."

The discovery of human bones in peat-bogs, in tumuli of unknown antiquity, in mines, &c., does not bear upon the present subject.

The opinion, then, of the best informed and most observant geologists, is, that Man is of recent creation,—that he was called into being when the surface of the earth, having undergone a series of modifications, and having assumed, on a broad scale, its present aspect, became fitted for his reception. Against the opinion of his comparatively modern date, some philosophers have brought the chronological records of the Chinese and Brahmins, and the presumed zodiacs of the ancient Egyptians. With respect to the fabulous chronology of the Chinese and the Brahmins, it is unworthy of serious notice, as evidence in the case. With respect to the zodiacs of the Egyptians, it is now, we believe, admitted, that the great temple of Dendera, whence the celebrated zodiac, now in Paris, was obtained, is not anterior to the time of Augustus: the small temple of Esné, that of which the origin, as indicated by the zodiac there discovered, was, according to the lowest calculation, near 3,000 years anterior to the Christian era, has a column sculptured and painted in the sixth year of Antonine, 147 years after Christ; and it is painted and sculptured in the same style as the zodiac which is near it.

These celebrated planispheres have been the test to which many philosophers have, as they thought, triumphantly appealed, in favor of the antiquity of our race. Dupuis referred the construction of the zodiac of Dendera to an era 13,000 years before the present: and others, of no little learning, have fallen into conclusions as extravagant. After all, it appears, that these zodiacs have nothing to do with the precession of the equinoxes, or with the displacement of the solstice: they are not true zodiacs, nor were the Egyptians profound astronomers. Cuvier observes, that "a mummy-case, lately brought from Thebes, by M. Caillaud, and containing, according to the very legible Greek inscription upon it, the body of a young man, who died in the ninth year of Trajan, 116 years after Christ, presents a zodiac divided at the same points as that of Dendera; and all the appearances indicate, that this division marks some astrological theme relative to the individual; a conclusion which may, probably, be equally applied to the division of the zodiacs contained in the temples."

In fact, as already observed, neither the tables of the Chinese and Brahmins, nor the zodiacs of the Egyptian temples, are worthy of the slightest serious attention. Thus, neither monuments, nor the productions of man, discovered in tumuli, in the ruins of ancient cities, or mines, worked at an unknown period, such as glass ornaments, weapons, tools of brass or stone, stamped bricks, and the like,—not tradition, extravagant as may be its pretensions,—nor history,—throw back to a remote era the commencement of the existence of the human race; and the assignment of 6000 years, as the average of the period during which man has acted his part on the surface of the globe, accords alike with the inferences of the geologists and the cosmogony of the Mosaic writings.

APPARATUS FOR EXPERIMENTS ON POLARIZED LIGHT.

Single Reflecting Planes.—Light may be conveniently polarized by a single plate of any transparent body without double refraction, such as glass, obsidian, ebony; or by a single surface of water, oil, treacle, and varnished body, or any ordinary crystallized surface. But in selecting any plate or surface, it should be one which has a low dispersive and refractive power; for it is only in this case that the reflected light will be completely polarized. Glass of antimony, oil of casia, flint glass of high refractive power, colored or stained glasses, are all unsuitable for this purpose. A plate of thin well-annealed crown glass (if with parallel surfaces, so much the better) will answer for ordinary experiments.

Reflecting Bundles of Plate Glass.—When a great deal of light is required, which is frequently the case, especially when we use the microscope for examining imperfectly transparent bodies, from one to sixteen plates of the clearest and thinnest annealed glass should be placed in a frame, having their surfaces well washed and cleaned with fresh chamois leather. Their edges must then be covered with cement, or with wax, so that no dust may introduce itself between the plates. If the glass is thin and with little color, the light reflected from its surface will be as bright as that reflected from a quicksilvered mirror, and will consist wholly of polarized light, when the rays are incident upon it, at the polarizing angle. The light transmitted may be also used.

Reflecting Bundles of Blown Glass.—As it is extremely difficult to obtain thin plates of clear and colorless glass, even if we take flint glass, which is not desirable from its high dispersive power, we may substitute in their place films of glass blown to the utmost thinness, and place them in a trough between two plates of the thinnest glass. The light transmitted through this bundle may be also used.

Reflecting Bundles of Mica.—Take a piece of clear and transparent mica, as colorless as possible, and cut it into the form of a right-angled parallelogram, whose sides are parallel and perpendicular to the plane passing through its resulting axes. Hold it by an edge in a powerful vice, and with a lancet, or a thin-bladed knife, split it into ten or twelve laminæ, or more if necessary. Before taking it out of the vice, cover all its edges with a coating of wax or strong cement, so that, after the laminæ are separated from one another, they may have the same relative position as before their separation. This bundle of mica films, when taken out of the vice, is one of the best means of polarizing light that can be used; but the light must be polarized by reflexion in a plane parallel to either of the sides of the bundle. The best is that which is perpendicular to the plane passing through the resultant axes.—The light transmitted through this bundle being also perfectly polarized, may be used with great advantage.

Doubly-refracting Crystals of great Thickness.—When we can obtain a thickness of from three to six or more inches of colorless calcareous spar, it forms one of the most valuable pieces of polarising apparatus. We have only to place on one of the sides that contains the greatest thickness, a circular aperture just as large as that the two images of it may not overlap each other. We shall thus have two circular areas of light which are polarized, the one in one plane, and the other in a plane at right angles to it; and by means of a screen or a black wafer we can cover up the one circular space when we require only one kind of polarized light.

Doubly-refracting Prisms of Iceland Spar.—As it is not easy to procure large and pure masses of Iceland spar, a sufficient separation of the images may be obtained, by selecting a piece with one good natural surface, and grinding down the other, so that the common intersection of the two faces of the prism may be perpendicular to the axis or the plane of refraction, coincident with the plane of its principal section. The color of the images may be nearly corrected by a prism of crown or flint glass. By increasing the refracting angle of the prism, the separation of the images may be increased at pleasure. The objection so often made to the use of prisms of Iceland spar is not well founded, for it is capable of taking an admirable polish, equal indeed to its original surface; and even if the operator is not skilful in the art, the polish may be made perfect, and the surface preserved from injury, by cementing, on the two surfaces of the prism, two pieces of pure and parallel glass. When the prism is rendered achromatic, indeed, by a glass prism, the latter serves for one of the plates of glass, and one plate only is required for the other surface.

Single Image Prisms of Iceland Spar.—Prisms of this kind were first used by Dr. Brewster. The method of making them is to roughen as much as possible the two surfaces, or even one surface, of a prism of Iceland spar, and to cover it with grooves. A fluid or balsam with the same refractive index as the ordinary ray, is then placed between the rough surface of the spar and a plate of glass. This polishes, as it were, the surface for the ordinary ray, and allows it to pass through uninterrupted, in consequence of the spar and the fluid having the same index of refraction for that ray. The extraordinary ray, on the other hand, is scattered in all directions by reflection at the separating surface of the grooves and the fluid, and totally disappears, leaving only the ordinary image. But as there is no proper oil or fluid of such a high refractive power as 1.654, it is better to take an oil of the same refractive index as that of the extraordinary ray, for the surface which is roughened. If the oil does not exactly suit the surface, a slight inclination of the prism one way or another, will produce the adjustment. When this is done, we shall see the extraordinary image quite distinct, while the ordinary image has wholly disappeared. For ordinary purposes this prism is perfectly sufficient, but for others it will not answer so well, as the nebulous light seen all round, is polarized in a plane opposite to that of the extraordinary image.

Agate Plates and Microscopes.—Among the bodies of the mineral kingdom, Dr. Brewster found agate to be one which gave only one distinct image, all the light of which is polarized in one plane.—He therefore used it in his experiments. Agate microscopes, or plates of agate placed close to a single microscope, may be very advantageously used.

Tourmaline Plates.—M. Biot and M. Seebeck discovered that certain yellowish tourmalines, that is, those which are yellowish by refracted light, transmitted only one pencil polarized in the same plane, when cut parallel to their axis. It has been much used in experiments on polarization; but owing to the color which it produces, it is of no use whatever in researches where the phenomena of color are to be studied. When two plates of tourmaline or agate are placed in rectangular positions, not a ray of light is transmitted through them, not even the light of the meridian sun.

By using any of these pieces of apparatus, we can at all times produce either a ray, or a broad beam of polarized light; but when the structure of crystallized or organised bodies is examined by observing their affections under polarized light, the light transmitted through their substance requires to be analysed by a reflecting plate, or a doubly refracting prism, or a plate of tourmaline or agate which has the property of reflecting or transmitting one portion of the polarized, and allowing another portion to be seen which was in a state of combination with the first portion.

MECHANICAL DATA.

A square foot of *cast* iron, 1 inch thick, weighs 38 lbs. 10·7 oz.; of malleable iron 39 lbs. 13·1 oz; of copper 47 lbs.; and of lead 59 lbs.—Other thicknesses in proportion.

The momentum or force of a body is its matter multiplied by its velocity, and this is the basis of all mechanics and all philosophy. Velocity is as the space passed through in the same time; therefore, matter and space are the source of all material power; and wherever power is present, there is some matter in some motion.

Action or parting with motion by one body, is always equal to the re-action or reception of it by another.

Motion, or force, is propagated in a mass in measurable time, and this is the cause of the resulting motion from impact. The side struck receives its motion first, and this moves the whole body. If the force were communicated at once to the whole, no direction would be given to the resulting velocity.

Universally to determine the power of a machine, divide the velocity of the action by the velocity of the power. For the actual force of the effect, multiply this by the force of the power, and allow a third or fourth for friction.

In wheel-machinery, to determine the number of revolutions of the last-moved part for one of the first-moved part, divide the product of the cogs in the driving wheels by the product of the cogs in the driven wheels

The mechanical powers may be reduced to three; but they are usually expressed as six, the lever, the wheel, and axle—the pulley, the inclined plane, the screw, and the wedge.

In a single moveable pulley, the power gained is doubled. In a continued combination, the power is twice the number of pulleys, less 1.

In levers, the power is reciprocally as the lengths on each side the fulcrum or centre of motion.

The force necessary to move a wheel-carriage on a level road is about one-twenty-fifth of the load; on a railway it is but the 150th; on a canal it is but the 600th.

On an inclined plane, the power gained is as the length of the plane to the length of the base. The velocity, in descending to that, falling perpendicularly is as the height to the length, and the force is the same. For a body acquires the same velocity as in falling perpendicularly through the height of the plane; and a body acquires the same velocity in falling down any number of planes, or down a curve, as perpendicularly from the extreme height.

A body, moving down an inclined plane, moves four times as far in two seconds as in one.

The power of the screw is as the circumference to the distance of the threads, or as 6·2832 to that distance.

The power of the wedge is as the length of the two sides to the thickness of the back.

The diameter of the wheel of a pulley should be five times its thickness. The pin one-twelfth, and one-twelfth on each side allowed for play.

Brunel's block machine, at Portsmouth, unites the action of sixteen different machines in one steam engine—seven for the shell, and nine for the sheave. Ten men to do the work of 110. It makes about 200 sorts and sizes of blocks; *i. e.* 72 sizes of thick blocks, 48 of thin blocks, 10 of clue-line ditto, 20 sister blocks, 20 topsail ditto, 24 fiddle ditto, 20 jack ditto. Of which varieties, the machines make 1420 blocks per day.

A seventy-four gun ship requires about 1300 blocks, and there are 200 different sorts and sizes, varying from 1 to 28 inches in length. Every gun requires six blocks.

The pendulum, for true and exact measuring of time, was a suggestion of Galileo. Every oscillation, whether long or short, of the same pendulum, is performed nearly in the same time.

A pendulum which vibrates seconds at London, ought to be 39·139 inches.

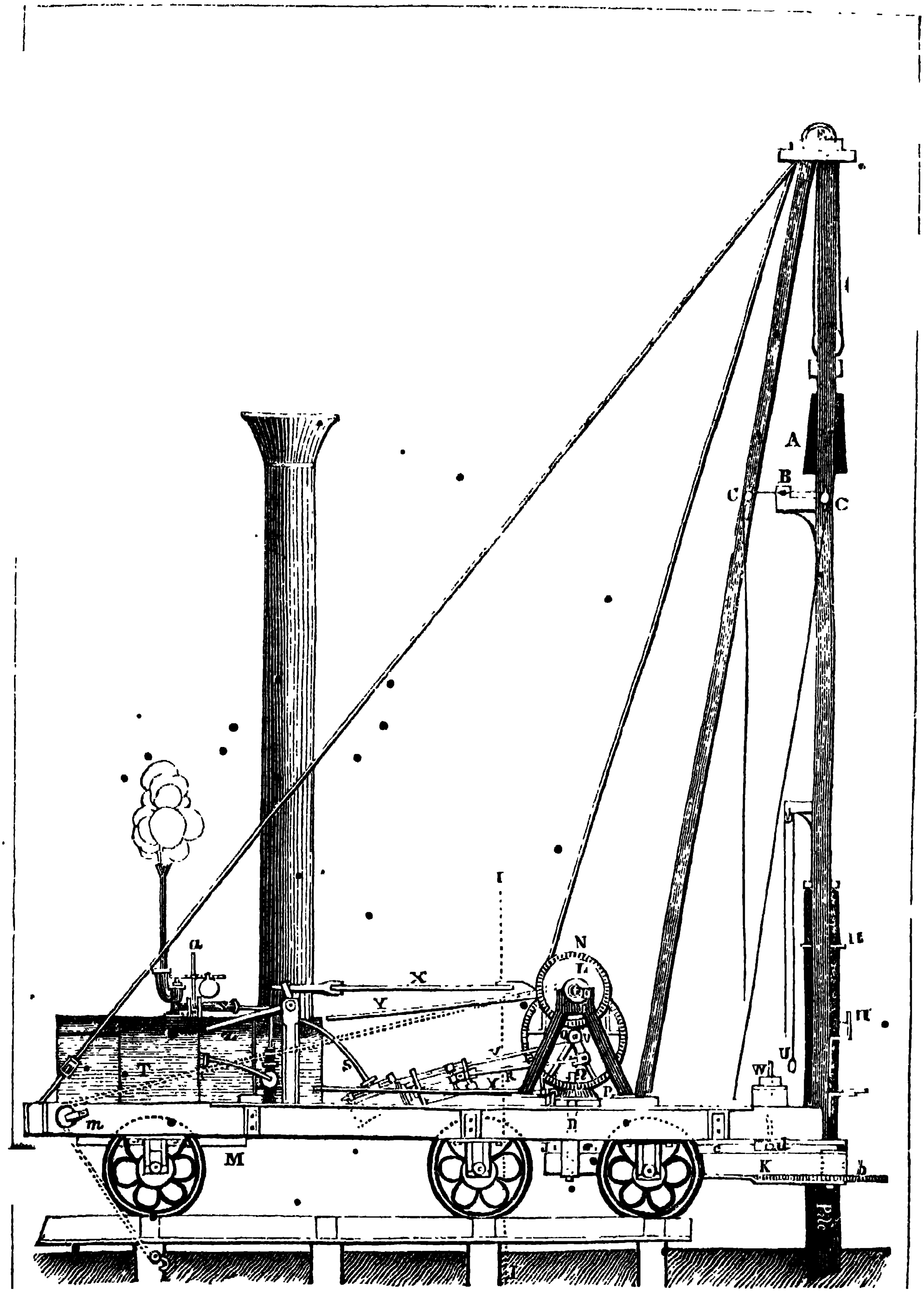
The length of pendulums for less or greater times, is as the square of the times; thus, for half a second, it would be the square of $\frac{1}{2}$, or $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$; so that $\frac{39·139}{4} = 9·78425$ inches is the length of a half seconds pendulum at London. For quarter seconds, it would be $\frac{1}{16}$; and for two seconds 2 × 2, or four times.

At St. Thomas's, in lat. 0·25′, the seconds pendulum is 39·02069; and at the Gallipagos, in lat. 0° 32′, it is 39·01717; at Maraham, in 2° 32′, it is 39·01197.

The superincumbent pressure so drives wate[illegible] into the pores of wood at great depths in the sea, as in an hour to increase its weight $\frac{21}{25}$, and its bulk $\frac{1}{20}$.—*Scoresby.*

The draft of a waggon of 216 cwt. on pavement is 33 lbs.; on a gravel road 147 lbs.; on M'Adam's road 46 lbs. Horses always turn from a road to a paved road.

The pressure of fluids is distinct from the weight of their mass. It is as the height whatever the base. A cone and cylinder of liquid of equal height has the same pressure; but, if frozen, the weight of the cylinder of ice would be three times that of the cone. The lateral pressure of the fluids is also equal to the perpendicular.



THE AMERICAN STEAM PILE DRIVING MACHINE.

THE AMERICAN STEAM PILE DRIVING MACHINE.

In a former number we gave a brief account of this machine, which has been exhibited for the last two months at Smith's Wharf, Pedlar's Acre, Lambeth. The machine was imported into this country from the United States, by Colonel Cowdin, and some other parties, and consists simply of a locomotive engine, similar in principle to those used on our railways, having two inclined cylinders with their connecting rods working upon cranks attached to the ax[illegible] of two crab engines, instead of the wheels of the locomotive engine. The two crab engines perform the operation of driving the pile with a ram of the same weight, and in the same manner as those generally adopted for all the large works in this country, such as the coffer dam to the New Houses of Parliament and the bridges. With this machine two piles are driven at the same time.

In America the steam machine has been generally adopted for the construction of railways on piles, for which purpose it is well adapted, for as soon as the machine has driven a pair of piles, it cuts off the heads to a level, or with a slight inclination, according to the *grade* required for the railway, and then rails are laid upon the top either with cross sleepers or not, as may be desired; the engine advances forward another length, and performs the operation again: thus one engine is enabled to drive two rows of piles at about five feet apart, one mile in a month.

The principal object of inquiry is to see how far this machine is superior to those in ordinary use, and as we just stated, in the steam machine we have simply engine power applied instead of manual labor, for the working of two pile driving machines of the same magnitude and power as those in ordinary use. For this purpose it is absolutely necessary to make a series of observations, and ascertain the number of piles that can be driven in one day by the steam machine, and the cost of labor, fuel, and expenditure of capital, in comparison with the labor consumed in driving the same number of piles by the ordinary machine. At present, our materials do not warrant us in offering any opinion, but we shall hereafter attempt to obtain some information regarding this very important part of the inquiry.

For the steam machine, it requires to work the engine and apparatus for driving two piles at one time, with a ram weighing 16 cwt., the following men:—An engine-tender, one man for throwing each apparatus in and out of gear, and one man to attend to each pile, making altogether five men for driving *two* piles. For the ordinary machine, it requires four men to work the crab engine for lifting a ram of the same weight, and one man to attend to the driving of the pile, making five men for *each* pile, or ten men for two piles. With the steam machine the ram is lifted four or five times in a minute, thereby the operation of driving the piles is very short in comparison with the ordinary machine. The cost of the steam machine, with an engine of ten-horse power, tubular boiler, and apparatus, is about 700*l.*, and the cost of the ordinary pile driving machine, with crab engine, is about 70*l.*

The following is a description of the American steam pile driving machine, and the operations for which it is applicable:—

The machine consists of two pairs of leaders, similar to the common hand machine, placed 6 feet from centre to centre, (the common American railway gauge,) and firmly bolted to a strong horizontal framing, and supported by two oblique ladders. The frame is 9 feet wide to the outside of the framing, and 28 feet long; it carries at one end a locomotive boiler, 11 feet long and 2 feet 6 inches diameter, calculated to bear 120 lb. per square inch pressure, but generally worked at 80 lb. per square inch, and about 100 strokes per minute. Under the boiler is placed the supply cistern. In the centre of the framing, and on each side of the boiler is a pair of inclined cylinders, 5½-inch bore, with solid pistons working well without packing, and 14-inch stroke, which act on right-angled cranks; and the gearing, drums, &c. described in the motions of the machine; the shaft centres are 1′ 3″ apart; the spur wheel has 56, and pinion 19 teeth; bevels 101 and 40 teeth; saw pulleys 1′ 9″ and 10½ inches diameter. The ram is generally raised from four to five times a minute, the steam being at 80 lb. per square inch.

For river-work, the machine is made much more compact; the apparatus is placed on each side and over the boiler, so that the stage is little more than half the length of the machine shown in the engraving, and it is also sometimes made with an apparatus for driving one pile only, consequently requiring smaller power.

The drawing is a side elevation of the machine.

Taking up the Pile.—The ram A being secured by placing the stop B under it, by means of the small ropes attached to the latter, and passing over the small pulleys C C, to within three feet of the stage. The dogs are made fast to the pile; the rope attached to which passes upwards through the small guide pulleys, and over the outer pulley E at the top; passes downwards, and is coiled round the drum L fixed on the shaft G, which being made to revolve, raises the pile to its place between the leaders, and is then secured by the loose stay and iron-work H placed round it for guiding it perpendicularly.

Driving the Pile.—The stop B being withdrawn from under the ram A, the ram is raised by a rope, which being secured to a staple on the top journal, passes down under the pulley above the ram; then upwards over the pulley K, and again downwards to the drum L, upon which the rope is coiled; the drum is placed on the shaft G, which is made to revolve by the spur-wheel N, working in the pinion O, on the lower shaft P, which shaft revolves by the action of two cranks placed on each end of the shaft P; the cranks are set at right angles to each other, and are worked by the connecting rods R, attached to the piston rods, which are furnished with slide parallels, as shown in figure. The slide valves of the piston are work by the eccentric V, on the end of the shaft. Steam is supplied to the cylinder by the pipe S, from the boiler T. The boiler is supplied with water from the cistern M, by the pump, which is worked by the eccentric rod X, fixed on to the spur-nave at Y, or by the handle at Z; the supply of steam is regulated by the handle, *a*, acting on a valve in the steam pipe. The drum L consists of a fixed and a loose cylinder; the latter revolving by the friction of the former, (fixed,) and is brought into or out of contact by the hand lever Y, which has a fulcrum attached to the standard.

The follower is furnished with a pair of tongs or clippers, which takes hold of a staple fixed in the ram, and carries it to the top of the frame; then when the top of the tongs is pressed closer together, by coming between the contracted cheeks, the lower part opens and allows the ram to fall.

For working the apparatus, the engine-tender stands at the valve S, and a man at the lever Y of each machine. For raising the ram, the man turns on the steam at the valve S, which sets in motion the apparatus of each machine, and coils the rope round the drums, at the same time raises the ram; as soon as the latter reaches the top of the leaders, the ram is detached and descends; at the same moment the engine-tender turns off the steam, and the men at the levers Y throw the drum out of gear, which allows the clippers and chain to descend again and lay hold of the ram; when the drum is again thrown into gear, the steam turned on, and the ram again raised, and so the operation is continued until the pile is driven.

Drawing a Pile.—Chain tackle is secured to the pile, and passed over the top pulley to the drum L, and is then drawn by applying the power to turn the drum of the apparatus.

The Saw Apparatus consists of a circular saw, *b*, 4 feet diameter, having teeth set 3 inches apart, secured to the end of the beam K, which beam works on an upright shaft for a centre, and slides laterally on the iron arc *e*; when used, the saw is adjusted to the proper height by the screws W; and a bar having a hook in one end and fitting into a staple in the beam's end, is used to press the saw against the work. Motion is given to the pulleys and band which work the saw. The operation of sawing off the end of a pile takes less than a minute.

Progressing Motion.—The hook being fastened to a driven pile, and the rope passed over the pulley *m* attached to the side of the frame to the pulley G, round which it is coiled twice, and the end held by a man: motion being now given to the drum, the machine progresses—this motion is shown by the dotted rope. It should be stated that the frame is intended to be supported upon six railway wheels, which run on a temporary rail laid on the top of the piles as they are driven. There is another mode of progressing, but which is not found to answer so well, viz. by means of two sledge beams faced with iron, and attached to the under framing; these are placed six feet apart from centre to centre, and pass under the whole length of the machine, and slide on small iron wheels fixed to standards, which are placed loose on the piles.

The plumb-bob U suspended to a line, regulates the pile, being driven perpendicularly; and Y is a lever attached to a friction band-break passing over the end of the drum, which is only used asionally.—*Civil Engineer's Journal.*

AQUA AND MEZZOTINTING.

We gave an account of this species of engraving, as practised on the continent where it was originally invented, on page 292. The British artists have greatly improved upon it. The first thing is to etch or dry-point an outline of the subject in the manner which we have already described. The plate is then properly cleaned with whitening, so as effectually to remove any grease. A solution of resin is used as a ground. The resin is reduced into a powder, more or less fine, according to the kind of subject to be represented, and put into a bottle with spirit of wine. The plate is placed in any vessel, sloping in an inclined plane of about fifteen degrees; and the composition of the spirit of wine and resin poured over its surface in a slow and uniform manner, taking care to cover the face of the plate without having to repeat the operation; the spirit of wine will run off, and be caught in the vessel, and what remains will soon dissipate, leaving a beautiful and uniform surface of the particles of the resin, which will adhere firmly to the copper. The outline can be distinctly seen through this transparent ground, and the biting or corrosion is proceeded with as before directed. When this is completed, the parts which require rounding must be done with the scraper and burnisher.

It may be easily conceived that there is some difficulty in producing spirited touches in landscapes, or in giving freedom to the foliage, by the method of simply stopping up with varnish; to obviate which a very ingenious plan has been devised, by which the touches are laid on the plate with the same ease as India-ink on a drawing. The finest quality of whiting must be mixed with a little treacle, and diluted with water. The touches are then made with a camel-hair pencil. The whole plate is then covered with a varnish of turpentine and asphaltum, and permitted to dry. When the acid is applied, it will be found that those places which have been touched with the whiting and treacle will immediately break up, and expose those touches to the action of the acid, while the other parts of the plate will completely resist it.

Engraving in Mezzotinto differs entirely from the manner above described. This method of producing prints, which resemble drawings in India-ink, is said by Evelyn, in his "History of Chalcography," to have been discovered by Prince Rupert. Some accounts say that he learned the art from an officer named Siegen, or Sichem, in the service of Hesse-Cassel. It has been, for many years past, a very favorite way of engraving portraits and historical subjects; of the former, the large heads of Fry are of superior excellence. The tools required for this easy and rapid mode of proceeding are, the grounding tool, the scraper, and the burnisher.—The copper-plate should be prepared as if intended for the graver, and laid flat upon a table, with a piece of flannel spread under it, to prevent the plate from slipping; the grounding-tool is held perpendicularly on it, and rocked with moderate pressure backwards and forwards, till the teeth of the tool have equally and regularly marked the copper from side to side; the operation is afterwards repeated from end to end, and from each corner to the opposite; but it is necessary to observe, that the tool must never be permitted to cut twice in the same place; by this means the surface is converted into a rough chaos of intersections, which, if covered with ink and printed, would present a perfectly black impression upon the paper. Some modern artists have found that it is much more easy and expeditious to grain the plate by only bringing the grounding tool twice over it. This practice produces a much more dotty and richer effect, and saves half the time besides. No outline is made on the copper, but the picture is divided into squares, and a similar number of smaller lots drawn on the copper with a black lead pencil. This is the most tedious part of the process. The rest, to a skilful artist, is much more easy than line-engraving or stippling. It consists in pressing down or rubbing out the roughness of the plate, by means of the burnisher and scraper, to the extent of the intended figure, obliterating the ground for lights, and leaving it for shades. Where a strong light is required, the whole ground is erased. For a medium light it is moderately burnished, or partially erased. For the deepest shades the ground is left entire. Care is taken to preserve the insensible gradations of light and shade, upon which the effect and harmony of the piece essentially depend. Engraving in mezzotinto approaches more nearly to the effect of oil paintings than any other species, from the strong and broad effects of light and shadow which it is capable of producing. It is well calculated for the representation of obscure pieces, such as night scenes, &c. The principal objection to the method is, that the plates wear out speedily under the press, and, of course, yield a comparatively small number of impressions. But, since the use of steel plates has been discovered, a much greater number of impressions can be taken off, although much fewer than in line and other engravings.

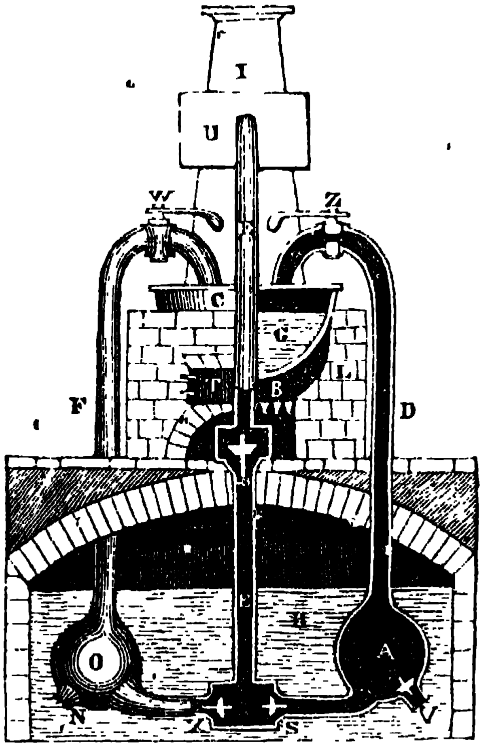
STEAM AND THE STEAM ENGINE.

(Resumed from page 310.)

In our last paper upon this subject, we considered it necessary to give a succinct account of that extraordinary man, the Marquis of Worcester, who is almost universally admitted to have been the real inventor of the steam engine. "Though," as Professor Robison observes, "the account he has left of it is not sufficient to give us any distinct notions of the structure and operation of his engine, yet it is exact as far as it goes, agreeing precisely with what we know of the subject." But the Professor afterwards adds, "that the account is such that it could instruct no person who was not sufficiently acquainted with the properties of steam, to be able to invent the machine himself; his descriptions seem not so much intended to instruct the public as to raise wonder, and his encomiums on their utility and importance are, to a degree, extravagant." It is, indeed, a matter of considerable doubt if his steam apparatus was ever, in reality, in action at all; yet machines, which bear the name of the Marquis of Worcester, are made, not as exact counterparts of his, but rather as models, showing how his description might have been brought to bear. One of these models is represented annexed; it is the contrivance of Professor Millington.

The two spherical vessels A O have two pipes D F proceeding from them, and inserted into a boiler G. These pipes have two stop-cocks Z W, which shut off the communication between the boiler and the vessels. From another part of the vessel proceeds two other pipes, having valves at S X, opening outwards, and terminating in a single pipe E. The spherical vessels have each another valve opening inwards, and a very short pipe N V. The pipe E rises 40 feet, and terminate in the receiver U. B is a section of the fire grate, under the boiler E; T the door of the fire-place; L the brick-work; G the ashpit; and H the reservoir of water in which the vessels O A are placed, and which is to be elevated into the cistern U.

If we now suppose a sufficient quantity of steam to be generated in the boiler C from the water G, and the stop-cock Z, opened so as to allow a free communication between the boiler and the vessels in the reservoir, the steam will descend in the pipe D (the pipes and vessels being made or cased with some material to prevent the condensation of the steam by the water in the reservoir,) into the vessel A, and will expel all the water or air which it may contain through the valve S, into the pipe E, which will deliver it in the reservoir U. The cock Z is now to be shut, and the valve V, being freed from the pressure of the elastic vapor, will be forced inward by the gravity of the water in the reservoir, which will speedily fill the vessel A. But when the cock Z is shut, the opposite one, W, is opened, and the steam from the boiler raises the water which may be contained in O, up the pipe E, closing in this operation the valve S. When the vessel O is filled with steam, the cock W is shut, and the water in the reservoir rushes into O, as it did into A, and fills it. The cock Z is now opened, and the steam again expels the water from the vessel A; and so on successively, so long as steam is produced in the boiler, and the cocks Z W are opened and shut alternately.

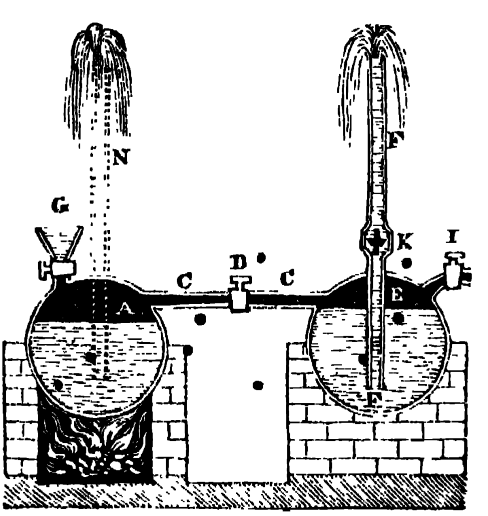


Mr. Millington remarks, that this engine agrees so far with the Marquis of Worcester's description, where he says, that "a man has but to turn two cocks, and that one vessel of water being consumed, another begins to force and refill." He also observes, that the condensation of the steam opens and shuts the valves, and fills the vessels, but that this use of the vacuum is part of an invention to which the Marquis has no claim, his Lordship expressly stating, that "the water *is not* raised by drawing or sucking it upwards." The "force and refill" in the original account would almost lead to the supposition that these operations were going on at the same moment, in the same vessel. The arrangement of pipes, cocks and valves is also gratuitous.

Besides which, it is impossible to decide from Lord Worcester's description whether *two boilers* are meant, and *one receiving vessel;* or *two vessels,* and *one boiler?* Or only two vessels, like De Caus's, probably having each an eduction-pipe and the proper cocks, to produce a continuity in the stream of water?—as in the next figure, where the dotted lines rising from the vessel A would then represent this pipe, the fire being made under each boiler alternately. And, when mention is made of one vessel of water rarefied by fire, driving up forty of cold water, should not this be understood as the proportion of water which would be converted into steam, in order to raise the remaining portion in the *same vessel*, forty feet high? An apparatus designed on this supposition, would satisfy the description nearer than any.

Having so wide a choice, we will give the Marquis credit for an apparatus for generating the steam in a *separate boiler*. A will therefore be that boiler; C, a pipe (having a stop-cock D,) connecting the boiler with the cold water vessel E, from which proceeds the eduction-pipe F; G, a pipe and funnel to supply the boiler with water; H, a similar pipe-cock to supply the vessel E with cold water connected with a cistern, from which the water is to be raised; I, is a stop-cock on this pipe; K, a valve to prevent the return of the water which may be in the upper part of the pipe F.

When the steam in the boiler A is allowed to enter the cold water vessel E, by turning the cock D, the water is raised in jet through F, until the vessel E is emptied. When this is the case, the cock D is shut, and I is opened, and the vessel E is again filled with cold water. The cock I is then shut, and the stop-cock D is opened; and the steam from the boiler pressing on the surface of the water in E, forces it up the pipe F. When this is emptied the same operation is repeated, and so on successively. So that here the condition of the alternate opening and shutting *two cocks* is fulfilled; also the forcing and refilling of the vessels; and one vessel of water rarefied by fire would elevate double the quantity of that stated by the Marquis.



(To be continued.)

CAUSES OF DROWNING.

Dr. Arnott, in his popular *Elements of Physics*, states the following reasons why, in ordinary accidents, so many persons are drowned who might easily be saved:—1. Their believing that the body is heavier than water, and therefore that continued exertion is necessary to keep them swimming; and hence their generally assuming the position of a swimmer, in which the face is downwards, and the whole head has to be kept out of water to allow of breathing. Now, as a man cannot retain this position without continued exertion, he is soon exhausted, even if a swimmer; and if not, the unskilful attempt will scarcely secure for him even a few respirations. The body raised for a moment by exertion above the natural level, sinks as far below it when the exertion ceases; and the plunge, by appearing the commencement of a permanent sinking, terrifies the unpractised individual, and renders him an easier victim to his fate. 2. From a fear that water by entering the ears may drown, as if it entered by the nose or mouth, a wasteful exertion of strength is made to prevent it; the truth being, however, that it can only fill the outer ear, or as far as the membrane of the drum, and is therefore of no consequence. Every diver and swimmer has his ears filled with water, and with impunity. 3. Persons unaccustomed to the water, and in danger of being drowned, generally attempt in their struggle to keep their hands above the surface, from feeling as if their hands were tied while held below; but this act is most hurtful, because any part of the body kept out of the water in addition to the face, which must be out, requires an effort to support it, which the individual is supposed at the time incompetent to afford. 4. The not having reflected that when a log of wood, or a human body, is floating upright, with a small portion above the surface, in rough weather, as at sea, every wave in passing must cover the head for a little time, but will again leave it projecting in the interval. The practised swimmer chooses this interval for breathing. 5. Not knowing the importance of keeping the chest as full of air as possible, the doing of which has nearly the same effect as tying a bladder of air to the neck, and without other efforts will cause nearly the whole head to remain above the water. If the chest be once emptied, while from the face being under water the person cannot inhale again, the body remains specifically heavier than water, and will sink.

NEBULÆ.

In astronomy, the name given, on account of their general cloudy appearance, to a very numerous class of celestial objects, being, however, for by far the greater part, *telescopic*, and only visible in telescopes of considerable powers.

It is to Sir William Herschel that astronomy is indebted for the first examination and analysis of these remarkable objects. A few of them, indeed, have been known since the discovery of the telescope, and one or two of them are visible to the naked eye; but his powerful telescopes first disclosed the fact of their existence in immense numbers, and in all quarters of the heavens, not indeed distributed uniformly, but, generally speaking, with a marked preference to a broad zone, crossing the milky-way nearly at right angles, and whose general direction is not very remote from that of the hour circle of 0 hour and 12h.

Nebulæ are divided by Sir W. Herschel into the following classes:—1st. Clusters of stars, in which the stars are clearly distinguishable; 2d. Resolvable nebulæ, or such as excite a suspicion that they consist of stars, and which any increase of the optical power of the telescope might be expected to resolve into distinct stars; 3d. Nebulæ, properly so called, in which there is no appearance whatever of stars; 4th. Planetary nebulæ; 5th. Stellar nebulæ; and, 6th. Nebulous stars.

Clusters of Stars.—These are either globular or of an irregular figure, forming bright isolated patches, which attract attention, as if they were brought together by some general cause. The Pleiades is a cluster of this sort: the naked eye can distinctly perceive six or seven stars in it, and may catch occasional glimpses of a great many more; but the telescope shows fifty or sixty crowded together, in a very moderate space, and insulated from the rest of the heavens. A luminous spot, called *Præsepe*, or the Beehive, in the constellation Cancer, is resolved entirely into stars by an ordinary telescope. In the sword-handle of Perseus is another such spot, crowded with stars, but not so easily resolved. There are a great number of less distinct nebulous specks of the same kind, which in ordinary telescopes have much the appearance of comets without tails, and have frequently been mistaken for such; when, however, they are examined with instruments of great power, such as reflectors of 18 inches, 2 feet, or more in aperture, any such idea is completely destroyed. They are then, for the most part, perceived to consist entirely of stars, crowded together so as to occupy almost a definite outline, and to run up to a blaze of light in the centre, where their condensation is usually the greatest. Many of them are of an exactly round figure. Others, again, are of an irregular form, and less definite in their outline, so that it is not easy to say where they terminate. In some of them the stars are nearly all of a size, in others extremely different; and it is no uncommon thing to find a very red star, much brighter than the rest, occupying a conspicuous situation in the group. Sir W. Herschel regards these as globular clusters in a less advanced state of condensation; conceiving all such groups as approaching, by their mutual attraction, to their globular figure, and assembling themselves together from all the surrounding region.

Resolvable Nebulæ are considered as objects of the same nature as the preceding; but as being either too remote, or consisting of stars too faint to affect us by their individual light. They are universally round or oval; their irregularities of form being extinguished by the distance, and only the general figure of the condensed part being discernible. In telescopes of insufficient optical power, all the great globular clusters exhibit themselves under this appearance.

Nebulæ, properly so called, present a great variety of appearances. One of the most remarkable is in the constellation Orion; and its appearance is very different from what might be supposed to arise from the aggregation of an immense collection of small stars. It is formed of little flocky masses, like wisps of cloud; and such wisps seem to adhere to many small stars at its outskirts, and especially to one considerable star, which it envelopes with a nebulous atmosphere of considerable extent and singular figure. This nebula was discovered by Huygens in 1656, who gave figures representing its appearance in his telescope. On comparing these with its present appearance, several astronomers have concluded that it has undergone a perceptible change; but the evidence of such change is by no means to be relied on. There is a nebula in the constellation of Andromeda visible to the naked eye, and often mistaken for a comet. Its appearance is described by Simon Marius as that of a candle shining through horn. Its form is a pretty long oval, increasing by insensible gradations of brightness, at first very gradually, but at last more rapidly, up to a central point, which, though very much brighter than the rest, is yet evidently not stellar, but only nebulous matter in a high state of condensation. It has in it a few small stars; but they are obviously casual; and the nebula itself offers not the slightest appearance to give ground for a suspicion of its consisting of stars. It is nearly half a degree long, and fifteen or twenty minutes broad. Like that last described, a very numerous class of nebulæ are of a round or oval figure, increasing more or less in density towards the central point. In this respect, however, they differ extremely; in some the condensation being slight and gradual, in others great and sudden. They also present great diversity of appearance, in respect of deviation from the spherical form. Some are only slightly elliptic, others much extended in length; and in some the extension is so great as to give the nebula the character of a long, narrow, spindle-shaped ray, tapering away at both ends to points. Some nebulæ are annular; but these are among the rarest objects in the heavens. The most conspicuous is situated half way between the stars β and γ Lyræ, and may be seen with a telescope of moderate power. It is small, and particularly well defined, so as to have, in fact, much more the appearance of a flat oval solid ring than of a nebulæ.

Planetary Nebulæ have exactly the appearance of planets,—round or slightly oval disks, in some instances quite sharply terminated, in others a little hazy at the borders, and of a light exactly equable, or only a little mottled, which, in some of them, approaches in vividness to that of actual planets. Whatever the nature of these objects may be, they must be of enormous magnitude. One in Aquarius presents a diameter of 20″; another, in Andromeda, has a visible disk of 12″, perfectly defined and round. Granting them to be equally distant from us with the stars, their real dimensions must be such as would fill, on the lowest computation, the whole orbit of Uranus. Their intrinsic splendour must also be immeasurably inferior to that of the sun's; for a circular portion of the sun's disk, subtending an angle of 20″, would give a light equal to 100 *full moons*, whereas the nebulæ in question are hardly discernible with the naked eye.

Stellar Nebulæ are those in which the condensation of the nebulous matter towards the centre is great and sudden; so sudden, indeed, as to present the appearance of a dull and blotted star, or a star with a slight burr round it. The ***nebulous stars*** present the beautiful and striking phenomenon of a sharp and brilliant star, surrounded by a perfectly circular disk or atmosphere of faint light: in some cases dying away on all sides by insensible gradations, in others almost suddenly terminated. A very fine example of such a star is 55 Andromedæ, R. A. 1h 13m, N. P. D. 50° 7′.

"The nebulæ," says Sir J. Herschel, "furnish, in every point of view, an inexhaustible field of speculation and conjecture. That by far the largest of them consist of stars there can be little doubt; and in the interminable range of system upon system, and firmament upon firmament which we thus catch a glimpse of, the imagination is bewildered and lost. On the other hand, if it be true, as, to say the least, it seems extremely probable, that a phosphorescent or self-luminous matter also exists, disseminated through extensive regions of space, in the manner of a cloud or fog, now assuming capricious shapes, like actual clouds drifted by the wind, and now concentrating itself like a cometic atmosphere around particular stars, what, we naturally ask, is the nature and distinction of this nebulous matter? Is it absorbed by the stars in whose neighbourhood it is found, to furnish, by its condensation, their supply of light and heat? or is it progressively concentrating itself, by the effect of its own gravity, into masses, and so laying the foundations of new sidereal systems, or insulated stars? It is easier to propound such questions than to offer any probable reply to them."

PREPARATION OF SULPHURIC ETHER.

ETHER is usually obtained either by distilling a mixture of sulphuric acid and alcohol, or by suffering alcohol gradually to dribble into the heated and somewhat diluted acid. Mr. R. Phillips' directions for the former process are as follows:—"Mix with 16 ounces of sulphuric acid, an equal weight of rectified spirit, and distil about 10 fluid ounces; add 8 ounces of spirit to the residuum in the retort, and distil about 9 fluid ounces; or continue the operation until the contents of the retort begin to rise, or the product becomes considerably sulphurous; mix the two products, and if the mixture consist of a light and heavy fluid, separate them: add potash to the lighter, as long as it appears to be dissolved; separate the ether from the solution of potash, and distil about nine-tenths of it, to be preserved as *ether sulphuricus*, the specific gravity of which ought to be at most .750."

Preparing ether upon a larger scale, it was found that 14 parts of alcohol (specific gravity .820) mixed with an equal weight of sulphuric acid (specific gravity 1.8), and submitted to distillation, afforded about 8 parts of impure ether (specific gravity .770). Seven parts of alcohol were then added to the residuum, and about 7¾ parts more of impure ether drawn off. These products, when mixed, had a specific gravity of about .782, and when rectified by distillation on carbonate of potassa, afforded 10¼ parts of ether, of a specific gravity of .735, and about 3½ parts of ethereal spirit, which was employed instead of an equal quantity of alcohol in the next operation.

These processes, when carried on on a small scale, may be conducted in glass retorts with adopters and cooled receivers; but upon the large scale, a leaden still or alembic is most convenient. The ether-apparatus employed at Apothecaries' Hall, consists of a leaden still, heated by means of high-pressure steam carried through it in a contorted leaden pipe; a tube enters the upper part of the still, for the purpose of suffering alcohol gradually to run into the acid in a way which will presently be explained. The still-head is of pewter, and is connected by about 6 feet of tin pipe, with a very capacious condensing-worm, duly cooled by a current of water; the receivers are of pewter with glass lids, and have a side tube to connect them with the delivering end of the worm-pipe. In conducting this operation, too much caution cannot be observed in avoiding the proximity of fire, and the use of fragile vessels; in all cases in which ether is to be dealt with these cautions cannot be too strictly enforced, as will be more evident when its properties are stated. One of the great advantages in using steam as the source of heat is, that it obviates the necessary vicinity of fire.

Boullay's process for the production of ether, which is preferable to the former, is the following:—Equal parts of sulphuric acid and of alcohol (specific gravity ·837) are cautiously mixed in a tubulated retort connected with a tubulated receiver by means of a long adopter; the retort is placed in a sand-heat, and the receiver cooled by the proper application of water. An S tube passes air-tight through the tubulature of the retort the lower end of which is drawn out into a very small or almost capillary opening, and so adjusted as to dip to about two-thirds of the depth of the liquid in the retort: heat is then applied by the sand-bath till the contents of the retort just begin to appear to boil; the fire is then slackened or damped so as to keep up a regular ebullition, and as the apparatus is air-tight, the expansion within is suffered to escape by a siphon tube, which passes through the tubulature of the receiver. When about 2 pints of product have passed over, an equal quantity of alcohol is so gradually suffered to trickle into the retort by the S tube, as not to check ebullition, but to compensate for that which distils over; when, in this way, a quantity of alcohol has been added equal to that contained in the original mixture, the operation is generally left to itself, and as soon as white vapors and drops of oil appear in the adopter, the fire is withdrawn. The products of this distillation are usually divided into three parts; the first is alcohol with a little ether, which first passes over; the second and largest portion is mixed with a sixteenth of its weight of carbonate of potassa, which abstracts water and sulphurous acid, and decomposes any oil of wine that may chance to be contained in it; this mixture is shaken, and when the ether has acquired a sweet and pure odor, it is rectified by slow distillation from a water-bath till two-thirds of it original bulk have distilled over; this portion is pure ether. The residue of the rectification is mixed with the last portion of the original distillation, and kept for some days in contact with the carbonate of potassa before used, and a little water and peroxide of manganese are added so as to get rid of the sulphurous acid; when this is done, the stratum of ether is drawn off and rectified, but it never equals in quality that of the former part of the process.

It will be observed that, in this process, a large additional quantity of alcohol is gradually added, and converted into ether by the original portion of sulphuric acid; and by obvious contrivances, the same thing may be effected with the still and apparatus used on the large scale.

Mitscherlich, in the first volume of his *Lehrbuch der Chemie*, has added some important facts to the preceding details, and has given a form of apparatus for the production of ether which well illustrates it. It consists of a large flask or bolt-head, the mouth of which is closed with a cork having three perforations, one of which allows the insertion of the thermometer by which the temperature of the contents of the flask can be regulated; the second admits of the passage of a small tube terminating at its upper end in a funnel, and at its lower, within the flask, in a capillary opening which dips into the liquid; from the third aperture a tube issues for the conveyance of the vapors generated within the flask into a proper condenser immersed in cold water; the end of this tube within the flask is slanted off, so that liquid forming in it may drop back into the flask and not obstruct the free egress of the vapor. Absolute alcohol is first poured into the flask, and then sulphuric acid, somewhat diluted, is gradually added, care being taken to prevent the heating of the mixture above 250° (120 *cent.*) The proportions are 100 parts of sulphuric acid, which already contains 18.5 of water, diluted with 20 parts of water, and mixed with anhydrous alcohol, in the proportion of 50 parts to every 100 of concentrated acid. To this mixture heat is applied, and it is kept boiling till the thermometer within the flask indicates 284° (140 *cent.*;) two strips of paper are then pasted upon opposite sides of the flask to indicate exactly the bulk of its contents, by showing the level of the liquid within it; alcohol is then suffered to flow in by the funnel-tube, the supply being so regulated as to maintain the boiling-point at 284°. If, having set out with 9 ounces of sulphuric acid, 1½ oz. of water, and 3 ounces of alcohol in the flask, the specific gravity of each successive 2 ounces that pass over into the receiver attached to the condenser be determined, that of the first 2 ounces will be 0.780, that of the two following 0.788, and this gradually increases to 0.798, at which the density generally arrives by the ninth or tenth ounce, and then remains constant; that being nearly the density of the alcohol used

If the precaution just stated respecting the adjustment of the temperature be strictly attended to, any quantity of alcohol may be etherized by the same portion of acid, which is no further altered than by foreign matters which may be accidentally present, or by the volatilization of a minute portion along with the ethereal vapour.

The liquid which passes over through the condensing-apparatus into the receiver, separates into two parts, the lighter stratum being ether, with a little alcohol and water; and the heavier, water, with a little alcohol and ether; and when the process has been carefully conducted, the weight of these products exactly corresponds with that of the alcohol consumed. In an experiment in which a large quantity of product had been obtained, it was found to consist of 65 ether, 18 alcohol, 17 water; now the quantity of water which should have been evolved in the production of 65 parts of ether is 15.4; so that the practical is as near to the theoretical result as could be expected, considering the impossibility of preventing the loss of ether by evaporation, and including errors of experiment. Careful manufacturers obtain from 100 parts of spirit of wine, containing 76 parts by weight of anhydrous alcohol, 60 parts of ether of the specific gravity 0.727; according to calculation, they should obtain 58 parts of ether of 0.724. With this diluted alcohol, the water which passes over is of course in greater quantity than when absolute alcohol is used.

The ether of commerce almost always contains alcohol, which materially affects its density; sometimes it also contains water, which is the case with what is termed *washed ether;* and if ether has been long prepared, it is often slightly acid, and leaves a peculiar odour when rubbed upon the hand. In order to procure from it perfectly *pure ether*, it must be well shaken in a close vessel with about twice its bulk of water, and allowed to separate upon its surface; it is then poured off, and a sufficient quantity of well-burned lime added to it, by which the water which it had acquired by the agitation is abstracted; the mixture of ether and lime is then distilled, care being taken to prevent all escape of vapour, and to keep the condensing-receivers cold, and the first third that distils over may be considered as *pure ether*, free from alcohol and from water.

MEMORANDA.

Height of Waves.—The highest wave which struck the French ship *Vénus*, during her voyage, was 7·5 mètres (23 feet); the longest wave was met with in the south of New Holland, and was three times the length of the frigate, or 150 mètres (492 feet).

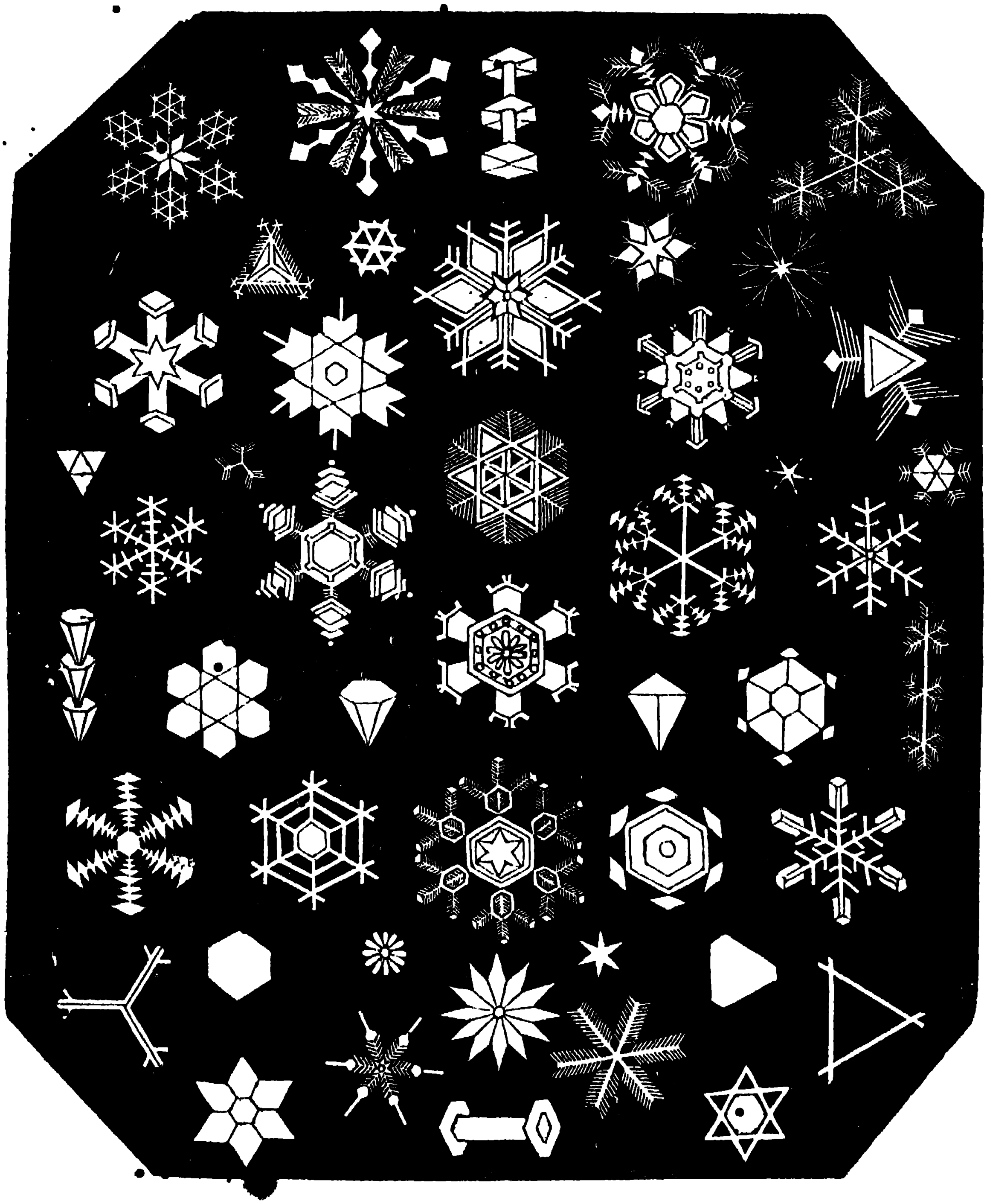
Motion in Rivers.—A fall of one-tenth of an inch per mile will produce a motion in rivers. The greatest velocity is at the surface and in the middle, and the least at the bottom and sides; but as the velocity increases, the action on the sides and bottom increase also. The mean velocities are as the area of the sections.

To Consume the Smoke from a Boiler Furnace.—Let the fresh coals be put into the furnace as near to the door as possible, and leave the door open for a space of two or three inches to allow cold air to enter, this will keep down the greater part of the smoke, which will be consumed; the same may be applied to marine engines. This method will be found as efficacious as any patent that has yet been taken out.

Safety Valve to Steam Boilers.—At a late meeting of the Society of Arts, the gold Isis medal was awarded to Mr. Robert M'Ewen, for a mercurial guage which answers the double purpose of an indicator of steam-pressure and a safety-valve for engine boilers. The novelty of the invention consists in the employment of a mercurial tube as a safe-vent for the steam, these tubes having hitherto been used only as indicators of pressure, and of a length sufficient to allow the steam to acquire a dangerous degree of pressure, without giving any other notice of the fact than what may be observed by the eye. As the action of Mr. M'Ewen's safety-valve depends on a purely *physical* principle, viz., the opposition of the elastic force of steam to the static pressure of mercury without a *mechanical* obstruction of any kind, it affords a free vent for the steam when its pressure exceeds the limit, corresponding to the length to which the tubes are adjusted, according to the strength of the boiler.

India Coal.—Dr. Hutchison, of the Madras artillery, has drawn up a report on the coal-fields recently discovered in the vicinity of Mergui, by which it appears that this coal is easy of access, lying at no great depth beneath the surface, so that shafts may be sunk without difficulty. For its conveyance there seems to be every facility, the river being adjacent, and a land-carriage of one mile only being required. It is not stated whether the quality of the coal has been tested by experiment, but we presume it to be the same of which Dr. Heifer spoke so highly in his communications. Steamers will begin to ply between [illegible] different ports in the bay of Bengal; and the immediate coal depôts between the Presidencies and Suez will be more plentifully supplied, and at a cheaper rate. The effect these circumstances will produce on the destinies of India can scarcely be estimated.—*East India Magazine.*

Herculaneum.—It is stated that the Neapolitan government have resolved upon undertaking some new excavations at Herculaneum and its neighbourhood, and it is added that they will be on an extensive scale. Negociations have commenced already with this view for the purchase of various estates on the spot; and so soon as these purchases have been completed, the works will be commenced. A commission of antiquaries and architects is to be appointed by the Minister of the Interior and the Royal Academy of Sciences to preside over the operations of the workmen; and no doubt discoveries will be made to add largely to the present knowledge of this interesting ruined city, and the manners and customs of its former inhabitants.



SNOW AND ITS CRYSTALLIZATION.

SNOW AND ITS CRYSTALLIZATION

Snow is formed in the air, when the temperature of the atmosphere sinks below the freezing point of water. The particles of moisture thus frozen form flakes, having great diversities of density, and displaying innumerable varieties of the most beautiful forms. Snow-flakes, examined by a microscope, appear to be regular crystals; and Scoresby, who has figured ninety-six varieties in his "Arctic Regions," arranges them under five forms, lamellar, spicular, pyramidal, &c. Like ice, and other crystallized bodies, snow would be transparent were it not that the air which it contains renders it opaque. The regular crystals are found only when the air is calm, and the cold intense, and do not often occur, therefore, in temperate regions. Snow has been seen in the polar regions of red, orange and salmon color. This occurs both on the fixed and floating ice, and appears, in some cases, to result from vegetable, and in others from animal matter, suspended in the sea, and deposited upon the ice around. Snow storms sometimes present a luminous appearance, covering all objects with a sheet of fire. The electricity of snow is generally positive. Snow-water has been found, by chemical analysis, to contain more oxygen than rain or river water—a fact which accounts for its superior activity in causing iron to rust, &c. Snow answers many valuable purposes in the economy of nature. Accumulated upon high regions, it serves to feed, by its gradual melting, streams of running water, which a sudden increase of water in the form of rain would convert into destructive torrents or standing pools, and, in many countries, tempers the burning heats of summer, by cooling the breezes which pass over it. In severer climates, on the contrary, it serves as a defence against the rigours of winter, by the protection which it affords to vegetation against the frost, and the shelter which it gives to animals, who bury themselves under the snow. Even in more temperate climates, vegetation suffers from an open winter; and it has been found that Alpine plants perished in the mild winter of England, from want of their usual snowy covering.

Of the form of the flakes of snow, Captain Scoresby, in his "Description of the Arctic Regions," thus observes:—"The extreme beauty and endless variety of the microscopic objects perceived in the animal and vegetable kingdoms, are perhaps fully equalled, if not surpassed, in both particulars of beauty and variety, by the crystals of snow. The principal configurations are the stelliform and hexagonal, though almost every variety of shape, of which the generating angle of 60° and 120° are susceptible, may, in the course of a few years' observation, be discovered." We have figured some of the crystals, of beautiful form, observed by Captain Scoresby; many of the smaller of them, and others equally symmetrical, we may observe in this country occasionally, though the majority have not been witsessed here except at rare intervals, when the cold is intense, and the snow falls in small flakes.

The *snow-line*, or plane of perpetual snow, is the elevation at which mountains are covered with perpetual snow. The progressive diminution of temperature, as we ascend through the air, must finally conduct us to a region of perpetual snow, the elevation of which is, of course, very different in different latitudes. On the northern side of the Himalaya mountains, it is about 17,000 feet; on Chimborazo, 15,802 feet. Humboldt fixes the altitude of perpetual snows, under the equator, at 15,748 feet. Towards the pole, it is much lower. On the Alps, under 46° north latitude, it is about 8860 feet. On the Pyrenees, it is stated by Humboldt at 1400 toises, or about 8850 feet. As we recede from the equator towards the north or south, it sinks more rapidly, and, at the North cape, in latitude 71°, it is estimated at only 366 toises or about 2440 feet. In Mexico, Humboldt, from the whole of his observations, made in 19° north latitude, places the elevation of the snow-line at 15,028 feet, or, at the lowest estimate, 14,708 feet. From the latitude of 19° to about 30° we are not acquainted with the altitude of a single snowy peak. Too little is known of the range of rocky mountains to enable us to state with accuracy their lowest plane of perpetual snow. In fact, besides the constant data of the latitude and elevation, the position of the snow-line depends so much upon variable causes, such as the form of the summits, the comparative altitude and other physical features of the surrounding country, the particular exposure of the mountains, &c., that no general rule can be given for determining the limits of perpetual snow in any given latitude, at least, with our present very imperfect information. Even the few facts which have yet been collected on this subject may stand in need of the corrections of more accurate measurements of heights, and, in addition to this, the plane of perpetual snow does not, by any means, maintain a constant elevation in the same latitude; but it varies with the vicissitudes of the seasons, rising during the heats of summer, and sinking by the cold of winter; changing also from one summer to another, according to the prevailing temperature of the year.

STRATIFIED NON-FOSSILIFEROUS OR PRIMARY ROCKS.

The primary strata are, gneiss, mica schist, hornblende schist, chlorite schist, talcose schist, quartz rock, primary limestone, and argillaceous schist.

Gneiss.—Gneiss may be called slaty granite. It is composed of the same ingredients as that rock, viz. quartz, felspar, mica, and hornblende united in various proportions, with the occasional absence of one or other of them, and the presence of a few other minerals. The distinctive character of gneiss consists in some of its component minerals, generally the mica and hornblende, being arranged parallel to the stratification, so as to impart to the rock a foliated appearance, or to give it a schistose character, sometimes so perfect as to admit of its being cleaved for economical purposes. This character becomes less perfect when the gneiss is in contact with granite, or traversed by veins of it, and at the point of contact [illegible] disappears entirely, so that the two rocks cannot, at their junction, be distinguished from one another. Fine-grained gneiss passes by the disappearance of felspar into mica schist; by the prevalence of quartz into quartz rock, and of hornblende into hornblende schist. The stratification of gneiss is irregular and contorted, the dimensions of the strata variable.—Where the rock occurs in large masses, they are thick; when they alternate frequently with others, they are thin. When they are not separated by such alternations, the distinction between the several beds is formed by a change in the proportions of the ingredients. Gneiss is, in many countries, the most abundant of the primary strata, occurring in large masses, which occupy extensive districts, and form lofty mountains, without any other alternating rock. In such cases it reposes upon granite, and is succeeded by the other primary strata, but in some cases succeeds one or other of these, the series alternating in large masses.

There are other instances in which a large series of strata, consisting principally of gneiss, contain alternating strata of other rocks in inferior proportions. The most common of these is hornblende schist; mica schist and quartz rock are next in abundance; argillaceous schist is more rare. Strata of gneiss are often invaded by veins of granite, which are not always transverse to the stratification but sometimes run parallel with it, assuming for short spaces the stratified appearance of gneiss, and, when of large dimensions, are liable, without very careful observation, to be mistaken for stratified granite.

The British localities for this rock are the Western Isles and north-west Highlands of Scotland.

Mica Schist.—Mica schist is a confusedly crystalline compound of quartz and mica, united in different proportions. It has a foliated or laminar texture, and is more or less fissile according to the proportion and mode of disposition in which the mica enters into its composition. It is sometimes capable of being separated into coarse slates; sometimes the laminar fracture is very irregular and imperfect. There are cases in which it approaches a granular texture; but when the quartz wears the most granular appearance, it is always united by a crystalline cement of that mineral.

Beds of mica schist are sometimes affected by large contortions, but there are many cases in which, when the contortions are minute and intricate, they seem only to involve the laminæ without extending to the bed itself.

The stratification of mica schist, when occurring, as is frequently the case, in large masses, occupying great tracts of country, is very difficult of detection. When the beds are not separated by alternating rocks, they are distinguishable, like those of gneiss, by changes in the proportions of their component parts. By the admission of felspar it graduates into gneiss; and by the preponderance of the quartz into quartz rock, with which it occurs extensively associated. The color of the different varieties of mica schist depends upon the quantity of mica which they contain, which varies in hue from white to black, the quartz being almost invariably colorless. The prevailing color of the rock is therefore grey, except when passing into chlorite schist, when it becomes green.

Mica schist differs from gneiss in not being traversed so much by veins of granite. These only occur in it when in contact with the granite, the veins being small, extending only a short distance from the mass, and their origin being easily traced; but it is subject to be much penetrated by veins of quartz, both transverse and parallel to the laminæ of stratification, and when these are contorted, the veins are contorted also.

Mica schist, like gneiss, forms extensive tracts of country and lofty mountains, but it also occurs in beds of a few feet in thickness, associated and alternating with gneiss and quartz rock.

The British localities are the Scotch Highlands and the north-west of Ireland.

Chlorite Schist.—The essential ingredients of this rock are chlorite and quartz, occasionally mixed with felspar and hornblende. It may be distinguished from mica schist by its green color and saponaceous feel. Its most extensive association is with mica schist, into which it passes in so sensible a manner, by the gradual mixture of the two minerals with quartz, that it is often difficult to decide which name to assign to the rock. It is under such circumstances that it forms masses of the greatest extent. It likewise occurs largely associated with argillaceous schist, into which it passes by a transition more or less perfect. It alternates in smaller strata with gneiss, and, by the addition of felspar, graduates into some of the chlorite varieties of that rock.

Chlorite schist, under a great variety of aspects, occupies a large portion of the Isle of Anglesea, and a small patch of it is found at the south-west extremity of Caernarvonshire.

Talcose Slate.—This rock is composed of talc alone, or of talc and quartz. It resembles the two preceding rocks, but is distinguished from them by the peculiar characters of the talc, and by its colors, which are lead-grey, white, and obscure green. It occurs only in beds of very limited thickness and persistency, imbedded in gneiss, mica schist, and chlorite schist, and in a few rare instances, in argillaceous schist, into all of which it gradually passes.

Hornblende Schist.—Under this term Dr. M'Culloch proposed to include all those compounds previously known by the names of hornblende rock, primitive greenstone, and greenstone-slate, whether possessing a schistose structure or not, which are clearly contemporaneous with the strata among which they occur. Its ingredients are hornblende and felspar, but the hornblende sometimes prevails to the exclusion of all other minerals. It occurs alternating with gneiss. It is rarely met with in large masses so as to form extensive tracts, without the alternation of other rocks. It is most frequently associated with gneiss, and less commonly with mica schist. When associated with argillaceous schist, it is occasionally observed to pass insensibly into that rock.

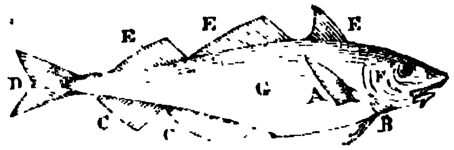
(To be continued.)

ANATOMY OF FISH.

Systematic Division of Cuvier.—Fishes are divided by Baron Cuvier into two series:—1. That of ordinary fishes, or, as they have been named by Mr. Jenyns, *Ossei*, distinguished by having the skeleton bony, the osseous matter being disposed in fibres; the sutures of the cranium distinct; maxillary and intermaxillary bones, either one or both present. 2. That of the *Cartilaginei*, or *Chondropterygii*, distinguished by having the skeleton cartilaginous; the bones destitute of fibres; sutures of the cranium indistinct; maxillary or intermaxillary bones, either wanting or rudimentary, their place being supplied by the palatine or vomer. We should naturally conclude, from observing the great diversity in the general form of fishes, that the structure of their skeleton must be equally various. They agree together, however, on the whole, in having a spine, which extends from the cranium to the tail-fin; and in having the other fins, particularly those of thorax and abdomen, articulated with peculiar bones destined to that purpose. They have, in general, many more bones unconnected with the rest of the skeleton than the animals of the preceding classes. The cranium in several cartilaginous fishes (in the skate for instance) has a very simple structure, consisting chiefly of one large piece. In the bony fishes, on the contrary, its component parts are very numerous, amounting to eighty in the head of the *perch*. Most of the latter have a more or less moveable under-jaw.

The Linnæan System of Ichthyology.—Fishes form the fourth class of animals in the Linnæan system, and are divided into six orders:—Orders 1, 2, 3, 4, are founded on the nature and situation of the *fins*, and also on the existence of *bony rays* in the gills; orders 5 and 6 are founded on a consideration of the nature of the *gills* and their appendages.

The fins are named according to their situation, as, A, pectoral fin; B, ventral fin; C C, anal fin; D, caudal fin, or tail; E E E, dorsal, or back fin; F, bony gill-covers; G, lateral, or side line. The ventral fins are held to be analogous to the feet of quadrupeds, and thus the first order, or *apodal*, embraces such fishes as want the ventral fins; order 2, or jugular, includes those with ventral fins placed before the pectoral; order 3, or thoracic, includes such as have the ventral fins immediately under the pectoral; order 4, or abdominal, comprises those which have the ventral fins behind or beyond the pectoral; orders 5 and 6 comprehend the cartilaginous division, and are founded on the nature of the gills and their appendages.

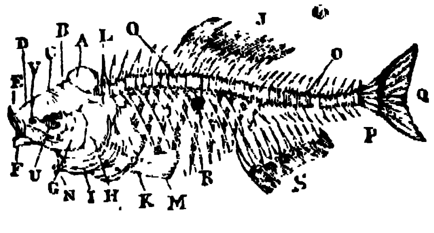


The Linnæan genera are derived from the situation of the fins, the shape of the body, the covering, figure, structure, and parts of the head, with the gills and their appendages. The Linnæan specific character is taken from the cirri, jaws, fins, spines, lateral line, digitated appendages, tail, and color.

Anatomy and Physiology of Fishes.—The anatomical examination of fishes forms an interesting branch of their natural history. An extended philosophical acquaintance with the human frame necessarily requires the aids of human anatomy, nor can a similar knowledge of the animals around us be fully acquired but through the means of comparative anatomy. It is thus that our views of organisation, and its ultimate application to the phenomena of life, become generalised and yet correct. It is thus that the causes of many apparent anomalies in the habits and manners of animals are developed; and it is by these means only that an arrangement of them into congenerous groups can be satisfactorily made. The systems of classification already noticed, and the characters which their authors have seized on for their formation, sufficiently show that something more was necessary than what had hitherto been done.

The osteology or bony structure of fishes is particularly remarkable from the circumstance already noticed, that in some of them the fabric is built on a bony, and in others on a cartilaginous base. This difference of structure is very important to the naturalist, as on it the two great primary divisions of fishes into bony and cartilaginous are formed.

A general idea of the plan of the fish bones may be gained from the skeleton of the carp; A, the occipital bone; B, the parietal; C, frontal; D, nasal; E, superior maxillary, or upper jaw-bone, which is moveable; F, inferior maxillary, or lower jaw; G, os quadratum, a bone peculiar to fishes, compounded of the branch of the lower jaw and the temporal bones; H, operculum, or gill-cover; I, radii of the branchiostegous membrane, by which the genera are characterised; J, dorsal-fin; K, a kind of humerus, or arm bone, to which the thoracic fin or forearm is attached; L, an imperfect scapula; M, thoracic fin; N, lingual bone; O O, the spine; P, extension of the last caudal vertebra for the attachment of the caudal or tail-fin; Q, caudal, or tail-fin; R, the ribs; S, anal or vent-fin; W, orbit, or cavity for lodging the eye.



It must not, however, be supposed that bones of one fish can be with propriety taken as a correct type of the whole. The general assemblage of their osseous fabric is altogether more complicated than that of most other animals. They vary in form and proportion very greatly in different species, and in point of number there is hardly any affinity among them, there being three times as many in one fish as in another; and this is particularly the case with the minute bones. Even in the division of fishes called osseous, the earthy part of the bones is smaller than in other animals, thus rendering them rather semicartilaginous than firm bone: and, on the other hand, in the cartilaginous fishes their cartilages are fortified by walls of ossified membrane; so that both divisions are somewhat approximated in structure, notwithstanding the distinctiveness of their appellations.

The cartilaginous skeleton is very difficult to exemplify by any individual figure. Some of the larger flat fish, as the skate, may have their cartilaginous fabric exemplified ere they fall into decay, but in the lesser cartilaginous fishes it is not an easy matter to represent them. There are head bones, so called; thoracic cartilages, or bones; a vertebral column extended into caudal vertebræ, or tail. There are also pelvic cartilages, or bones, to which the anal fins are articulated. Costæ, or ribs, are apparent, and surrounded by the pectoral fins, which in these flat fish appear like a continuation of the sides.

The bones of the head of fishes being covered with skin only, give to this part a very rugged outline; and in most of them the head is large in proportion to the body, and is as diversified in figure as in the number of bones that enter into its composition. For, while the perch has eighty bones in its head, and some other fishes have many more, others have not half the number. In all they unite by ossification, as age advances. The skull is articulated with the neck by a single tubercle of the occiput in some fishes, and in others by means of two condyles; but in all it is so joined as to admit of little motion, which would have been inconvenient, and as they receive their food horizontally, it would also have been unnecessary.

The teeth of fishes are not in general connected with the skeleton, and as by far the greater number do not masticate their food, their teeth are tentacular or hook-like; and are also variously placed, as in some on the tongue, in others on the palate, throat, and even on the cartilaginous arches of the gills. By means of these anomalous teeth they hold fast their prey, and when it is too large for perfect deglutition, they are enabled thus to retain it until the stomachic portion is dissolved. Such fishes as have no teeth within the mouth, are called *leathern-mouthed:* such are the carp, sturgeon, &c. In the pike, on the contrary, the teeth cover the mouth and throat most extensively.

The vertebral column is extremely varied in the number of its pieces, which, however, are determinate in nearly allied species. Artedi was induced to seize on them, as characters to distinguish the species; and the value of this anatomical fact is further proved in the investigations of Mr. Yarrell, who considers himself thereby enabled to determine that the diminutive fish *whitebait* is not the young of the shad (*Clupea Alosa*), as hitherto considered by naturalists, the number of vertebræ in the shad being invariably fifty-five, whereas in the whitebait it is uniformly fifty-six. The vertebral column is sometimes angular, often cylindrical, and occasionally compressed.

The ribs of fishes are very diversified, being double in some, forked in others, and in a third variety altogether wanting. With regard to shape, they are compressed in the carp, round in the cod, and bristle-shaped in the herring. Within the area of the gills, the sternum or breast bone, the scapulæ or shoulder blades, and the clavicles or collar bones, are placed. Thus, amidst diversities of character the most extraordinary, there is exhibited throughout animated nature a relative unity of design In flat fish the want of ribs is compensated by the extreme length of the transverse processes. Two pelvic bones also exist, which defend the abdominal viscera.

ARTIFICIAL CONGELATIONS.

It is a very singular phenomenon, and highly worthy of admiration, that a cold far exceeding that of winter can be produced even in the middle of summer; and what adds to the singularity is, that this production of cold does not take place unless the ingredients employed become liquid. Sometimes even by re-acting on each other they produce a strong effervescence.

I. Take water cooled only to the temperature of our wells, that is to say, to 54 degrees of Fahr.'s thermometer, and for every pint throw into it about 12 ounces of pulverised sal ammoniac; this water will immediately acquire a considerable degree of cold, and even equal to that of congelation. If a smaller vessel then containing water be put into the one containing this mixture, the water in the former will freeze, either entirely or in part. If it freezes only in part, make a mixture in another vessel, similar to the first, and immerse in it the half-frozen water: by these means it will be entirely congealed. If you employ this water half-frozen, or at least greatly cooled in the interior vessel, and throw into it sal ammoniac, the cold produced will be much more considerable: a cold indeed several degrees below that of ice will speedily be the result. If this mixture be made in a flat vessel on a table, with a little water placed between them, the ice formed below will make the vessel adhere to the table. The solution of the salt must be accelerated as much as possible, by stirring the mixture with a stick; for the speedier the solution, the greater will be the cold.

II. Pulverise ice, and for one part of it mix two parts of marine salt; stir well the mixture, and a cold equal to that of the severest winter will be produced in the middle of the mass. By these means Reaumur was able to produce a cold 13 degrees below congelation. Saltpetre, employed in the same quantity, will produce a cold only 3 or 4 degrees below freezing. It is a mistake therefore, as Reaumur observes, to imagine that saltpetre produces a greater effect than marine salt. Saltpetre is employed only because it is cheaper; and besides, when artificial cold is applied to domestic purposes, it is not necessary that it should be considerable. Instead of saltpetre, Alicant soda, or the ashes of green wood, which contain an equivalent salt, might be employed: the same effect would be obtained, and at a much less expense.

III. A cold much greater, however, than any of the preceding, may be produced in the following manner:—Take snow and well concentrated spirit of nitre, both cooled to the degree of ice; pour the spirit of nitre on the snow, and a cold 17 degrees below that of congelation will be immediately excited. If you are desirous of producing a cold still more considerable, surround the snow and spirit of nitre with ice and marine salt; which will produce a cold 12 or 13 degrees below zero; if you then employ the snow and spirit of nitre cooled in this manner, a cold equal to 24 degrees below zero will be the result. This cold is much greater than that produced by Fahrenheit; for it did not exceed 8 degrees of his thermometer below zero, which amounts to $17\frac{7}{9}$ degrees of Reaumur, below the same term. But this is nothing in comparison of what the philosophers of Petersburgh performed, towards the end of the year 1759. Assisted by a cold of 30 degrees and more, they cooled snow and spirit of nitre below that temperature, and by these means obtained a degree of cold which, reduced to the scale of Reaumur's thermometer, was more than 170 degrees[*] below zero. It is well known that at this term mercury freezes.

IV. There is still another method of producing a cold superior to that even which is necessary to freeze water. It is founded on a very singular property of evaporable fluids. Immerse the bulb of a thermometer in one of these fluids, such as well dephlegmated spirit of wine, and then swing it backwards and forwards in the air, to excite a current like that of the wind, which promotes the evaporation of the fluid; you will soon see the thermometer fall: by employing ether, the most evaporable of all liquors, you may even make the thermometer fall to 8 or 10 degrees below zero.

Very curious things might be said in regard to this property of evaporation; but to enlarge farther on the subject would lead us too far. We shall therefore only observe, that this method of cooling liquors is not unknown in the east. Travellers, who are desirous of drinking cool liquor, put their water into jars made of porous earthenware, which suffers the moisture to ooze through it. These vessels are suspended on the sides of a camel, in such a manner as to be in continual motion, which answers the same purpose as if they were exposed to a gentle wind, and which causes the moisture to evaporate. By these means the remaining liquor is so much cooled, as to approach the degree of congelation.

(To be continued.)

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[*] To reduce the degrees of Reaumur to those of Fahr multiply by 2¼, and add 32

POWER OF STEAM ENGINES.

In speaking of the power or force which an engine exerts, it is necessary to have some measure of force of standard of reference. That used in this country is a *horse-power*, a force equal to that which the average strength of a horse was believed capable of exerting. This has been estimated at 33,000 avoirdupois pounds weight, raised one foot high in a minute. There have been different estimates as to the real power of horses, and it is now considered that, taking the most advantageous rate for using horse-power, the medium power of that animal is equal to about 22,000 lbs. raised one foot high per minute. However, the other, 33,000 lbs., is taken as the standard, and is what is meant when a horse-power is spoken of. In comparing the power of a steam-engine with that of horses applied to do the same work, it must be remembered that the engine horse-power is 33,000 lbs. raised one foot per minute, the real horse-power only 22,000 lbs.; and that the engine will work unceasingly for twenty-four hours, while the horse works at that rate only eight hours. The engine works *three* times as long as the horse—hence, to do the same work in a day as an engine of one-horse power, 4.5 horses would be required—(33,000 × 3 = 99,000 :—99,000 ÷ 22,000 = 4.5). The power of a man may be estimated at 1-5th of the real power of a horse, or, 4,400 lbs. raised one foot per minute.

The following table from Tredgold, will convey some idea of the power procured from steam in Watt's double-acting engine :—

Let the force of the steam in the boiler be		1 000
The following deductions must be made :—		
Force impelling the steam into the cylinder	.007	
Cooling in the cylinder	.016	
Friction of piston, and loss	.125	
Force impelling the steam through the passages	.007	
Force to work valves, raise injection water, and overcome friction of axis	.063	
Loss from steam cut off before end of stroke....	.100	
Force required to work the air-pump	.050	
	.368	.368
		.632

Thus, about 4-10ths are lost from friction, working of the pumps, &c. The pressure in the boiler may generally be estimated at that of a column of thirty-five inches of mercury. The steam in the boiler is always kept a little stronger than the air—2½ to 4 lbs. on square inch, or, about 5 inches column of mercury.

If this be multiplied by .632, the proportion of the above force which remains after making the necessary deductions, as per the above table, it gives 22.12 inches, as the force of the steam on the piston represented in inches of a column of mercury: *i.e.*, 10.83 pounds to the square inch. 'But the uncondensed vapor in the cylinder resists this force. It also must be deducted from the above. If the temperature in the condenser be 120°, this vapor will have a force of about 3.7 inches of mercury, or, 1.81 lbs. to the square inch; 3-7 inches deducted from 22.12 inches, gives 18.42 inches of mercury—or, 1.81 lbs. deducted from 10.83 lbs. gives 9.02 lbs. per square inch, as the effective pressure on the piston. Calculated in circular inches, as is sometimes done, we have 7.1 lbs. to the inch.

The following extract from the author above quoted, will show the method of computing the power of an engine, the above data being assumed.

" *Rule.*—Multiply the mean effective pressure on the piston, by the square of its diameter in inches, and that product by the velocity, in feet per minute; the result will be, the effective power in pounds raised one foot high per minute.

" To find the horses' power, divide the result by 33,000. Example. The diameter of a cylinder of a double engine being twenty-four inches, the length of the stroke five feet,* the number of strokes per minute, 21½, and the force of the steam in the boiler, thirty-five inches of mercury, or five inches above the pressure of the atmosphere—required, its power.

" The velocity is 2 × 5 × 21½ = 215 feet per minute, and the mean effective pressure on the piston will be 7.1 lbs. per circular inch; therefore, 7.1×24^2 (the square of the piston's diameter, or 576) × 215 = 879,264 lbs. raised one foot high per minute; or,

$$\frac{879,264}{33,000}$$

26.64 horses' power. The nominal power of this engine would be only twenty horses' power, by Boulton and Watt's mode of calculation but it will be found that the nominal and real power nearly agree, when the steam acts expansively." Such an engine would require for steam, half a cubic foot of water per minute, or, thirty cubic feet hourly; and, allowing 8.22 lbs. of caking coal for every cubic foot of water, 216.6 lbs. of such coal would be consumed hourly; or, dividing 246.6 by 26.64, 9.2 lbs. of coal per hour for each horse power. It is said by some that the fuel consumed is about one-half more than this—14 or 15 lbs. per horse power hourly; this is the more general estimate.

In an engine working expansively, the steam being cut off at about one-half $(\frac{1}{21})$ of the stroke, the mean force would be, 4.8 lbs. on circular inch. This, multiplied as above, would give 594,432 lbs. raised one foot per minute, or, dividing by 33,000, eighteen horses' power. The fuel required, would be about one-half $(\frac{1}{21})$, 117 lbs. per hour, or, 6.5 lbs. per horse power, hourly, about 2.7 lbs. per horse power being saved every hour.

In a double-acting engine, of about twenty horse power, the diameter of the piston is about 24 inches, its area being 452 square inches, or 22.6 inches, for each horse power. The effective pressure on the piston may be about 7.3 lbs. per square inch. The length of stroke will be five feet, it will make twenty strokes per minute, and its velocity be 200 feet per minute. Such an engine would raise 660,000 lbs. one foot high per minute; and consume hourly 166 lbs. of coals, or 8.3 lbs. per horse-power. In smaller engines, the pressure on the piston is less, and the consumption of fuel greater. In large engines the reverse. In an engine of 200 horse power, the effective pressure on the piston may be about 8.9 lbs. per square inch, and, the coal consumed hourly is, per horse-power, only 5.5 lbs.

Mr. Tredgold estimates the deductions to be made from the force of the steam in the boiler in high-pressure engines, at about 0.4, the whole force being 1.0. The effective pressure thus, is 0.6. To find the power of a high-pressure engine, multiply the excess of the force of the steam in the boiler over the atmospheric pressure by 0.6; subtract from the product 4-10ths of the pressure of the air in pounds on a circular inch; multiply this product by the square of the diameter of the cylinder, and this, multiplied by the velocity of the piston, gives the number of pounds raised one foot high per minute.

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* A *stroke* means a motion of the piston, from the top of the cylinder to the bottom, and back again. When the *length* of a stroke is spoken of, only one half the stroke is meant. Thus, if the length of stroke be five feet, the stroke will be ten feet.

By the construction of the boilers of marine engines, they consume less fuel than land engines, some say in the proportion of two to three. Steam-vessels may now be expected to run at the rate of from 200 to 260 miles per day (allowing for bad weather, and stoppages for repairs), and, as at present constructed, may carry fuel for a voyage of about 3,500 miles. It is probable that the use of Howard's vapor engine, or others, may considerably extend the distances which steam-vessels can run without a fresh supply of fuel. The consumpt of fuel in steam-boat engines seems to be in general 10 or 10½ lbs. of coal per hour for every horse-power.

The following table shows the relative heating powers of the chief sorts of fuel in use for steam-engines:—

Kind of Fuel.	Pounds of water converted into steam of 222° (from 52°) by one pound of fuel.	Pounds of fuel required to form a cubic foot of water into steam
Caking coal	8.4 lbs.	7.45 lbs.
Splint coal	6.75 "	9.25 "
Coke	7.7 "	8.1
Dry pine	3.1 "	20.02 "
Dry oak	5.13 "	12.2 "
Dry compact peat	3.35 "	18.7 "
Charred peat	4.85 "	12.9 "
Culm (Glasgow)	2.85 "	22.0 "
Culm (Welsh)	3.56 "	17.5 "

In estimating the quantity in practice Mr. Tredgold from whom the above table is taken, adds 1-10th (10 per cent.); thus making 8.22 lbs. of caking coal the quantity necessary to vaporize a cubic foot of water. A cubic foot of water weighs 62 pounds avoirdupois. Equal heating power is obtained from 1 of Newcastle coal, 1⅓ of Glasgow coal, 3 of wood, and about twice as much culm as coal.

THE OCEAN.

The ocean is that vast body of water which surrounds the continents, and is the receptacle of all their running waters. It is divided by geographers into five great basins; viz. the Pacific Ocean, (so called by reason of its comparative stillness), which separates Asia from America, and is the largest of all the basins; 2. The Atlantic Ocean, which has Europe and Africa on its eastern shore, and America on its western; 3. The Indian Ocean, which washes the south of Asia, and the south-eastern coast of Africa; 4. The Arctic Ocean, which surrounds the north pole; and 5. The Antarctic, which surrounds the south pole. Other smaller portions of the great connected body of water are called *seas*, of which the Mediterranean, the German, the Baltic, and Black seas, are the most considerable. The superficial extent of the several great basins is not known with any certainty, nor, indeed, can their limits be exactly defined. From the nearest estimation that can be made of the extent of the continents and principal islands, it is supposed that nearly three-fourths of the whole surface of the globe are covered by water. The Pacific Ocean alone exceeds the whole surface of the dry land.

Depth of the Ocean.—If the superficial extent of the ocean cannot be easily ascertained, it will readily be supposed that its depth is a problem of much greater difficulty. The bottom appears, wherever it has been reached by the sounding line, to have similar inequalities to those of the surface of the land: hence the depth must be extremely various; and it might be supposed from analogy that the greatest depth of the ocean is at least equal to the height of the highest mountains above its surface. Lord Mulgrave found no bottom in the North Atlantic Ocean with a sounding line of 4680 feet: and Mr. Scoresby sounded to the depth of 7200 feet, without the lead touching the ground. These experiments are not altogether to be depended on for the determination of such great depths; for, the pressure becoming very great, the lead may be drawn out of the perpendicular direction by currents, of which it may encounter more than one, flowing in different directions. Over a great portion of the Atlantic and Pacific Oceans no bottom has been found. The depth of the ocean in general, and the form of the bed on which it rolls, cannot, therefore, be determined by experiment. The mathematical theory of the oscillations of fluids has, however, thrown some light on the subject. Laplace demonstrated that the difference which is indicated by observation between the height of two consecutive tides depends on the law of the depth of the sea, and that, but for the influence of accessory circumstances, it would disappear altogether if the depth were constant. It follows, therefore, that, since the difference between the consecutive tides is extremely small, the depth of the sea, taking in a large extent of ocean, must be nearly uniform; that is to say, there must be a certain mean depth from which the variations are not considerable.

Level of the Ocean.—Were it not for the disturbing actions of the sun and moon, and of the winds, the level of the ocean would be every where the same, and its surface would have the form determined by the attraction of the whole mass of the earth, combined with the centrifugal force belonging to its velocity of rotation; that is to say, the surface would be that of an oblate spheroid of revolution. This uniformity, however, can never be established. The tide at every instant is at different heights in different parts of the ocean; and therefore the form of the surface, within the limits of the rise and fall of the tides, is variable. But even if we neglect the alternate rise and fall of the water which constitutes the tides, and take the surface of the ocean as its mean height, it is found by accurate levelling that all its parts do not coincide with the surface of the same spheroid. Gulfs and inland seas, which communicate with the ocean by narrow openings, are affected according to their position with regard to the prevailing winds. The level of the Red Sea was found, by the French engineers in Egypt, to be 32¼ feet higher than that of the Mediterranean, which is supposed to be a little lower than the ocean. Humboldt concluded, from observations made on the Isthmus of Panama, that the waters of the Gulf of Mexico are about 2 feet higher than those of the Pacific Ocean. The Baltic and Black seas rise in spring from the great quantity of river water poured into them, and are lowered in summer by the joint effects of a small supply and increased evaporation.

Color of the Ocean.—The usual color of the ocean is a bluish-green, of a darker tint at a distance from land, and clearer towards the shores. According to Mr. Scoresby, the hue of the Greenland sea varies from ultramarine blue to olive green, and from the purest transparency to great opacity. The surface of the Mediterranean, in its upper part, is said to have at times a purple tint. In the Gulf of Guinea the sea sometimes appears white; about the Maldive Islands black; and near California it has a reddish appearance. Various causes co-operate, to produce this diversity of tint. The prevailing blue color may be ascribed to the greater refrangibility of the blue rays of light, which, by reason of that property, pass in greatest abundance through the water. The other colors are ascribed to the existence of vast numbers of minute animalculæ; to marine vegetables at or near the surface; to the color of the soil, the infusion of earthy substances; and very frequently the tint is modified by the aspect of the sky. The phosphorescent or shining appearance of the ocean, which is a common phenomenon, is also ascribed to animalculæ, and to semiputrescent matter diffused through the water.

Temperature of the Ocean.—Water being a slow conductor of heat, the temperature of the ocean is much more uniform than that of the atmosphere. At a certain distance from the equator, it follows, though not very closely, the mean temperature of the corresponding latitudes; the solar action being greatly modified by the existence of currents which convey the temperature of one region to another; so that at any place the temperature of the water depends in some measure on the direction of the currents. Within the tropics the mean temperature at the surface is about 80° of Fahrenheit, and generally ranges between 77° and 81°. At great depths the temperature is probably nearly the same under every latitude. In the torrid zone it is found to diminish with the depth; in the polar seas it increases with the depth; and about the latitude of 70° it is nearly constant at all depths. But the small number of observations which have yet been made on this subject do not indicate any uniform law, according to which the variation of temperature at different depths is regulated.

Saltness of the Ocean.—The ocean holds in solution a variety of saline matters, of which by far the most abundant is common salt, constituting in general about two thirds of the whole. The saltness of sea-water at particular places is influenced by temporary causes—storms, for example; as well as by the neighbourhood of large rivers, and permanent accumulations of ice. A series of experiments on this subject were made some years ago by the late Dr. Marcet; and the following are the general conclusions which he deduced from them:—1. That the Southern Ocean contains more salt than the Northern Ocean, in the ratio of 1·02919 to 1·02757. 2. That the mean specific gravity of sea-water near the equator is 1·02777. 3. That there is no notable difference between sea-water under different meridians. 4. That there is no satisfactory evidence that the sea at great depths is more salt than at the surface. 5. That the sea in general contains more salt where it is deepest; and that its saltness is always diminished in the vicinity of large masses of ice. 6. That small inland seas, though communicating with the ocean, are much less salt than the ocean. 7. That the Mediterranean contains rather larger proportions of salt than the ocean.

The peculiar bitter taste of sea-water does not appear to belong to it beyond a certain depth, and is ascribed to the vegetable and animal matter held in a state of decomposition near the surface.

MECHANICAL DATA.

The first iron rail-road was laid down at Colebrook Dale, 1786. Near Newcastle, there are 250 miles of iron rail-way above ground, and nearly the same beneath. In Glamorganshire there are 300 miles, from different coal-works and mines to quays.

An undershot wheel has the greatest force when its circumference moves with five-sixths of the velocity of the stream; and the best velocity of an overshot wheel is 3 feet in a second, and depends on proportioning the buckets, the power of the water being as the height it falls through. In the undershot wheel the power is to the effect as 3 to 1, and in the overshot wheel double, or 3 to 2.

One hundred pounds force of draught, or traction, at 4 miles per hour, draw 15,000 lbs. on a canal; 11,000 on a railway, and 1400 on a turnpike. At 10 miles, 2500 lbs. on a canal; 11,000 on a railway, and 1400 on a turnpike. A horse whose traction is 83½ lbs. will, in 8 hours, at 3 miles an hour, draw 240 tons on a canal; 92 on a railway, and 12 on a turnpike: or, in 2 hours, at 6 miles, will draw 30 tons on a canal; 18 on a railway, and 6 on a turnpike.

Stones for roads are broken to 6 ounces, but rounded pebbles do not imbed. Ten inches depth of well-consolidated materials are sufficient, whatever the substratum, and better soft than hard or rocky. Five tons of sized stones over a morass last as long as seven on a hard bottom.—*M'Adam.*

Seven or eight degrees is the greatest angle for carriages, fifteen degrees for beasts of burden; and thirty-five degrees cannot be ascended by a man without steps, and even with steps forty-four degrees is very difficult.—*Saussure.*

There are now in this country not less than 15,000 steam-engines at work, some of 1000 horse-power. Taking it that, on an average, these engines are each of 25 horse power, this would be equal to 375,000 horses. Five men and a half are equal to the power of a horse; we have thus, therefore, a power, through the medium of steam-engines, equal to near two millions of men. Each horse for his keep per year requires the produce of two acres of land, and thus 750,000 acres are at the disposal of the inhabitants, more than if the same work, which is now done by steam, were performed by horses.

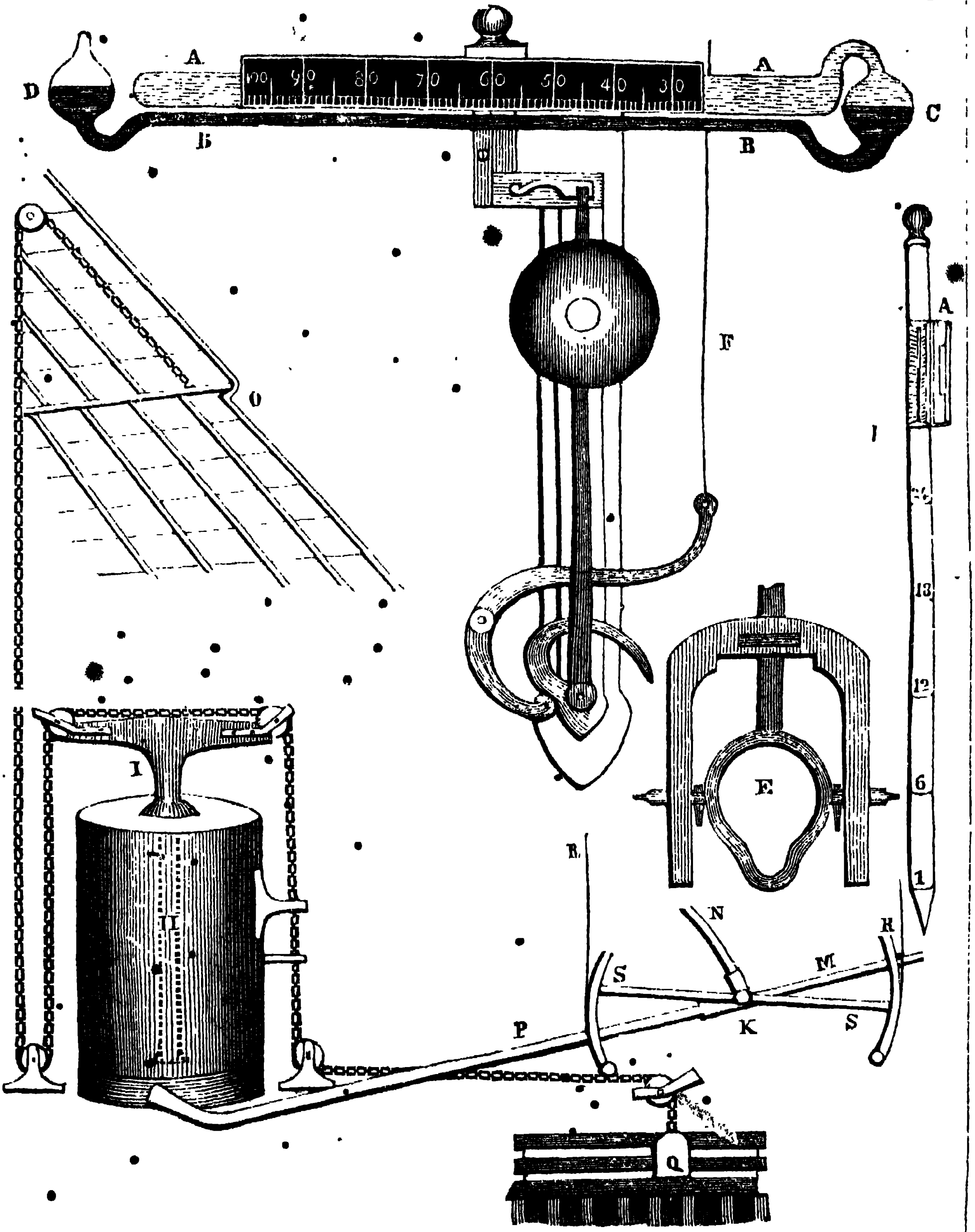
One of the most powerful steam-engines, in England, is that erected at Hawkesbury Colliery, near Coventry. Its cylinder is 58 inches in diameter; the piston moves 8 feet in a stroke, and makes 12 strokes in a minute; the pump is 14 inches in diameter, and the lift is 65 fathoms.

In 1751, a globular bottle was blown at Leith, capable of holding two hogsheads. Its dimensions were 40 inches by 42. The largest ever produced.

A landscape in perspective should not include more than an angle of 60 degrees, or one-sixth of the horizon. All lines perpendicular to the picture or perspective plane, vanish in the point of sight, and the size of objects is therefore inversely as their distance.

Owing to the centrifugal force, it is easier to do feats of horsemanship in a small ring, as at theatres, than if the animal were running on a straight road. The man and horse always inclining inwards, to counteract the centrifugal force, and if the rider tend to fall inwards, he has merely to quicken the pace; if to fall outwards, he has to slacken it.

Fig. 2.

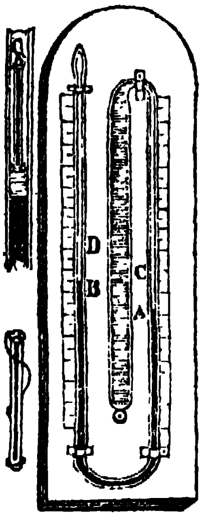


3.

HOT AND GREEN-HOUSE THERMOMETERS, &c.

HOT AND GREEN-HOUSE THERMOMETERS, &c.

The garden indicators of weather differ from those in common use only in two instances, that of the registering thermometer and regulating thermometer; together with such slight variations in the form of the usual instruments as better adapt them to the circumstances in which they are to be used. One of these slightly-varied instruments is *Bregazzi's Hot-house Thermometer;* it has a double back, the advantage of which is, that when hung from the roof of the hot-house, the heat of the sun is prevented from operating on the back of the bulb of mercury, by the current of air which passes between the backs. Another slightly-varied instrument is *Bregazzi's Bark-bed Thermometer* (Fig. 1), which has the bulb inclosed in a painted glass tube, by inserting which in the bark-bed, or in earth or water, the temperature will be indicated according to the depth of insertion. The visible part of the glass tube is protected by a small door, near the upper end of the instrument. *Six's Registering Thermometer*, of which a figure is given annexed, is so contrived as to indicate the extreme points to which it falls or rises in the course of the day or night, and is, therefore, particularly useful as a check upon the working gardeners, who have to attend to the fires, steam, &c. of hot-houses in the winter time. In the open air, and for ordinary meteorological observations, it is also a very useful instrument, from its pointing out the extremes of temperature. Its description is as follows:—



It is a spirit of wine thermometer, with a long cylindrical bulb, and a tube bent in the form of a siphon, with parallel legs, and terminating in a small cavity. A portion of the two legs of the siphon from A to B is filled with mercury; the bulb and the remainder of both legs, as well as a small portion of the cavity, are filled with highly-rectified and colored alcohol. The double column of mercury is intended to give motion to two indices C D; the form of which is better shown at the side. Each index consists of a bit of iron wire, inclosed in a glass tube, which is capped at each extremity by a button of enamel. Their dimensions are such, that they would move freely in the tube, were it not for a thread of glass drawn from the upper cap of each, and inclined so as to press against one side of the tube, forming a delicate spring of sufficient power to retain the attached index at any part of the tube to which it is driven by the mercury column. When heat expands the spirit in the bulb, it depresses the mercury in the limb A, and proportionably raises it in B, and with it the index; this last remaining fixed at the highest point that the mercury reaches. On the other hand, a decrease of temperature allows the side A to rise, and to carry up also its index; and thus the highest and lowest temperature since the last examination of the instrument is registered. The indices are again brought down to the surface of the mercury, by holding a small magnet towards them.

Kewley's Alarum Thermometer (Fig. 2) consists of a glass tube A A, about 10 inches in length, hermetically sealed at one end, and united at the other to a capillary tube B B, with an intervening and also a terminating ball C and D. Imagine this double tube placed in a horizontal position, the largest tube, and half the intervening ball, filled with spirits of wine; and the smaller tube and half of both of the balls, with mercury. If the tube is now fixed by its centre in a brass frame E, and nicely balanced, it is evident that every change in the temperature of the atmosphere will produce a change in the position of the centre of gravity of the tubes. One degree of heat, by expanding the spirit, will press on the mercury in the intervening ball C, and drive part of it over to the terminating tube D, which end will, in consequence, descend like the beam of a pair of scales, or of a steam-engine. Hence a moving power of great nicety and certainty is obtained, the details for the application of which, to the ringing of a bell at any distance, communicating by a wire F, need not be here entered into. Suffice it to say, that, by means of a scale G it may be set to any required temperature, and will give the alarm at a difference of even the fourth of a degree, either of depression or elevation. It may be occasionally used in gardening, to convey some idea of the changes taking place in the temperature of particular hot-houses, to the head-gardener's room, in the night-time; but its most important uses are in domestic economy, hospitals, &c. This balance-thermometer, as it may be called, has been also applied, by its ingenious inventor, to the opening and shutting of windows or sashes, valves of chimneys, or flues, and steam-cocks, and either to all of these purposes at once, or to any of them.

Kewley's Regulating Thermometer, or Automaton Gardener (Fig. 3) consists of a particular application of the alarum-thermometer just described. For this purpose, the thermometer is made from two to three feet in length, and the same principle may be extended to any length, as ten or twelve feet, with a proportionate increase in the diameter. The apparatus which Kewley applies to the thermometer, and which enables him to get the power requisite for opening the sashes or windows of hot-houses or buildings of any magnitude, is a metal cylinder H, generally of rolled copper, as being cheapest, from seven to fourteen inches in diameter, and from eighteen inches to two feet in length, with an accurately-fitted piston I. This cylinder is placed either within or without the hot-house or room, in any convenient situation, and a cistern, or a barrel, of ordinary dimensions, filled with water, is placed on an elevated situation, say on a level with the chimney-tops. The deeper the cylinder is sunk, the less the cistern requires to be raised above the level of the floor of the house. If, as is often the case, a pipe of water is conducted through the house from a distant reservoir of ordinary elevation, then nothing more is necessary than attaching a branch-pipe. It is requisite that this pipe pass directly to the point where the thermometer is placed, and at any convenient distance under it, not higher than the bottom of the cylinder. Here it is joined to a tripartite cock K, whence proceed two other pipes, one L to the cylinder, and the other M to a waste drain. The stopper to this cock turns only to the extent of about one-fifth of a circle; and when turned to this extent to the right, it opens a communication between the supply-pipe N, and the cylinder H, when the pressure of the water in the reservoir, whether a barrel on the top of a house, or a distant cistern, raises the piston, and by a communication of cords and pulleys with the sashes O, they will be raised or opened; and by another chain P, the fire or steam damper Q will be opened also. When the cock is turned to the left, this communication is stopped, and one opened between the cylinder and waste-pipe M, by which the water escaping the piston descends, and the sashes and dampers are shut. The equilibrium of the balance-thermometer restored by the temperature, being reduced or elevated to the proper degree, the plug is neither turned to the right nor left, and every communication is closed. The cock is worked by two wires R R, fastened to two short levers, fixed on each side of the thermometer-frame, and the other ends of the cross or handle of the cock S S. To set the machine at work, it is only necessary to place the scale to a degree at which it is desirable air should be given, taking care that the cistern is not without water. A small cask of water regularly supplied, will answer as well as a large cistern, as the power is not as the body of water, but as its height. As a hot-house seldom remains many minutes at the same degree of heat in the daytime, it is evident that the sashes would be in almost continual motion, which, in houses where the sashes open outwards, would have a singular and animated effect in a flower-garden, or on a lawn. Where light valves or ventilators are used, the balance-thermometer of this size has sufficient power to open them without the aid of machinery; and by lengthening the tube, sufficient power may be obtained to open balanced windows in dwelling-houses, churches, or hospitals. This machine was originally contrived for the use of the inventor in his own garden in Douglas (Isle of Man), and was successfully employed to give air to pits and frames there for two seasons. Having come to London, Mr. Kewley employed it with the addition of more machinery than he now uses, to ventilate a part of a house in the New Kent Road, from 1816 to 1817. In 1818 he greatly simplified it, and thus improved, it was in operation on a hot-house in Colvill's nursery, King's Road, during the summer of 1819.

CEROGRAPHY.

An account has appeared in the American papers of a new method of engraving, the nature of which appears to be unknown, though specimens have been published. The editor of the *Boston Daily Advertiser* says he has endeavoured, but without success, to form some conjecture as to the manner in which the work is executed,—"Being printed," he observes, "on a large sheet in common with the letter-press of a large newspaper, the plate must be of the character of a wood engraving, yet it possesses almost the delicacy of a copper-plate engraving, and abounds in lines which are evidently impracticable in wood engraving. The uniformity of the lettering, although varied by the diversity of characters afforded by the use of different founts of type, shows that this part of the work is of the nature of stereotype casting, but in what manner the shading, roads, and other arbitrary lines are inserted, it is difficult, from an inspection of the impression, to imagine, unless it be by some process of etching. From what is stated by the inventor, of the rapidity and cheapness of the execution, the size to which the plate may be extended, its adaptation to the rapid and cheap mode of printing, by which the ordinary book and newspaper printing is executed, we cannot but regard it as a very important and useful invention, particularly applicable to the printing of maps and drawings, in connexion with letter-press, for the illustration of works of almost every description." The *New York Observer* further states—"The advantages of cerography are, 1. The engraving of many subjects can be executed with a rapidity approaching very near to that of drawing upon stone; and the whole expense of a plate prepared for the press will ordinarily be less than that of a plate in copper or wood. 2. The plate is durable under the press. A million good copies may be struck from it; and as it can be stereotyped, the number of plates may be multiplied indefinitely at a trifling expense, and each plate will give a million copies. 3. Lines of all engravings, except, perhaps, the very finest class, can be made with nearly or quite the same perfection as in copper or steel, and with less labor. 4. We know of no limit to the size of cerographic plates. We suppose they may be made as large as the bed of the largest Napier press. 5. The printing is executed with the common printing press, and of course as rapidly as wood-cut or letter-press printing. With this statement, our readers can judge, as well as ourselves, of the effects which cerography, in the hands of accomplished artists, will probably produce on the other arts of engraving. We suppose that, with an improvement of which it is evidently susceptible, it will also have an important effect on the art of printing, especially on printing in the characters of the Chinese, Hindoo, and other Oriental languages. Even in its present state it will, no doubt, be used as a substitute for type-setting in some cases."

ARTIFICIAL STAINING OF MARBLE.

This art was practised by the ancients, and is described by Zosimus: it is now making considerable advance at Verona. The results are as follows:—A solution of nitrate of silver penetrates the marble, and communicates a deep red color to it. A solution of nitrate of gold penetrates less deeply, and communicates a beautiful purple violet color. Verdigrise sinks to the depth of a line into the marble, and gives a fine green color. A solution of dragon's blood communicates a beautiful red color, and gamboge a yellow tint. To apply these two colors it is necessary to polish the marble with a pumice-stone, to dissolve the gum resins in hot alcohol, and put them on with a camel-hair pencil. The tinctures obtained from woods, as Brazil wood, logwood, &c., penetrate deeply into marble. Tincture of cochineal, with the addition of a little alum, gives marble a fine scarlet color, similar to African marble. Artificial orpiment produces, when dissolved in ammonia, a lively yellow color. If verdigrise be boiled with white wax, and the mixture be applied to the marble, and then removed when it has cooled, it will be found to have penetrated five lines, and to have produced a fine emerald color. When it is wished to apply the different colors in succession, some precautions are necessary. The tinctures prepared by spirit of wine and by the oil of turpentine are to be applied to the marble while it is hot; but the dragon's blood and gamboge are to be used with the marble when cold. For this purpose, it is necessary to dissolve them in alcohol, and employ the solution of gamboge first. This, which is clear, soon becomes turbid, and affords a yellow precipitate. Those parts of the marble which are covered with the tincture are then to be heated, by passing over them, at the distance of half an inch, a red-hot iron plate, or a charcoal chauffer; it is then allowed to cool, and the iron is to be again passed over those portions where the color has not penetrated. When the yellow color has been imbibed, a solution of dragon's blood is to be applied in the same manner; and, while the marble is hot, the other vegetable colors may be communicated. The last colors to be applied are those in union with the wax. These must be used with great caution, because the slightest excess of heat causes them to penetrate deeper than is necessary, which renders them less adapted for delicate work. During the operation, cold water should be occasionally thrown upon them.—*Athenæum.*

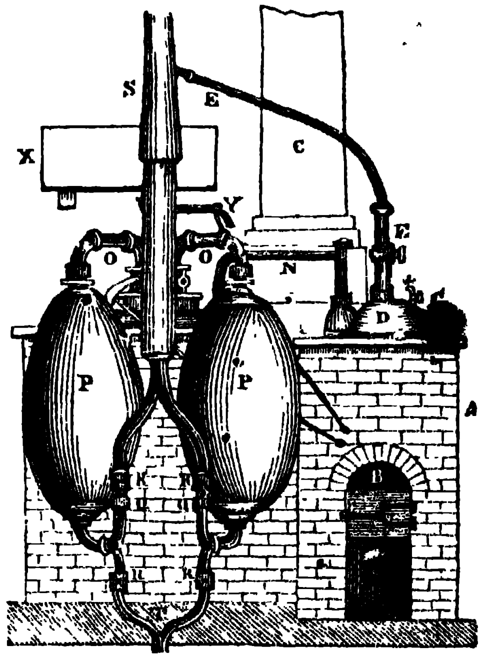
STEAM AND THE STEAM ENGINE.

(Resumed from page 333.)

It will be seen how very little had, till the time of the Marquis of Worcester, been done towards the formation of the steam-engine; so little, indeed, that we may consider it to have been scarcely invented at all, not a single part of even those given as the Marquis's agreeing with the engines of modern use; henceforth, however, inventions and contrivances will be found to succeed each other rapidly, each engine containing some important appendage, which preceding ones were without. As the first and most important of these, we may mention the inventions of Dr. Papin, a native of Blois, a man of great ingenuity, and of considerable acquirements as a philosopher, is considered by his countrymen to be the true inventor of the steam-engine. It is certain that he is the first who suggested *the safety valve.* Papin's *first* project, and it is necessary to keep this in remembrance, was to procure a first power by an *air-pump.* This scheme he announced as a means of enabling him to transmit, to considerable distances, the action of a mill by means of pipes. The cylinders of air-pumps, at one extremity, were made to communicate by pipes with equal cylinders, placed at the other and distant end, which, by some intermediate mechanism, were there connected to the piston rods of the pumps of a mine. This project failed even on the small scale of an experiment, from the prodigious resistance of the piston. Papin next tried to obtain a motion in a cylinder by the explosion of gunpowder, but here again it was found that without endangering the apparatus it was impossible to obtain power enough. He next suggested the employment of *steam* for forming the vacuum under the piston, and also for raising that piston by its elasticity. In this paper, which was published in 1690, he shows, that in a little water, changed into steam by means of fire, we can have an elastic power like air, but that it totally disappears when chilled, and changes into water; by which means he perceived that he could contrive a machine in such a manner, that with a small fire he would be able, at a trifling expense, to have a perfect vacuum, which he admitted could not be obtained by gunpowder. His was a happy thought, and had Papin persevered to make the experiment, he would, beyond all question, have produced the atmospheric engine; and although we cannot refuse to do this ingenious man the great honor due to having given the first idea, the merit of putting the scheme into practice is certainly due to another.

It was at this period that Captain Savery, a seafaring gentleman, offered an engine of his invention to the notice of miners, which showed as much ingenuity, depth of thought, and mechanical skill, as in any project of the age. He obtained a patent in 1698, after having published an account of it two years previously under the title of *The Miner's Friend.*

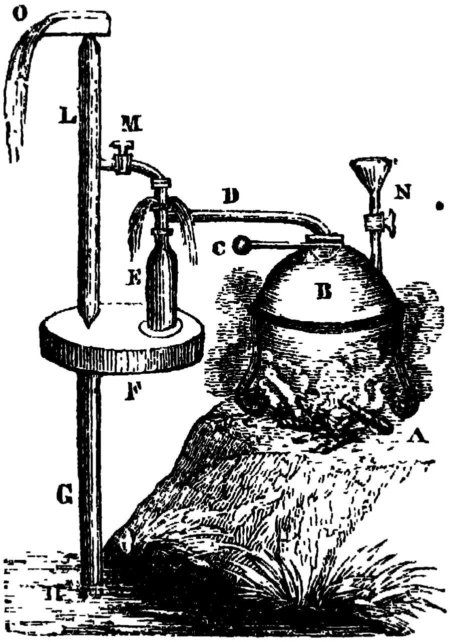
The following cut is given in Harris's "Lexicon," and the description of the engine is in the words of Savery's pamphlet, published in 1702:—



"The first thing," says the ingenious inventor, "is to fix the engine in a good double furnace, so contrived that the flame of your fire may circulate round, and encompass your two boilers, as you do coppers for brewing. Before you make any fire, unscrew G and N, being the two small *gauge pipes* and cocks belonging to the two boilers, and at the holes fill the great boiler, two-thirds full of water, and D, the small boiler, quite full. Then screw in the said pipes again as fast and as tight as possible. Then light the fire at B; and when the water boils, the handle of the regulator, marked Y, must be thrust from you as far as it will go: which makes all the steam rising from the water in L pass with irresistible force through O into P, pushing out all the air before it, through the clack R, making a noise as it goes; and when all is gone out, the bottom of the vessel P will be very hot. Then pull the handle of the regulator to you, by which means you stop O, and force your steam through O into the other P, until that vessel has discharged its air through the clack R up the force-pipe S. In the mean time, by the *steam's* *condensing* in the vessel P, a vacuum or emptiness is created, so that the water must and will necessarily rise up through the sucking-pipe T, lifting up a clack, and filling the vessel P.

"In the mean time, the other vessel P being emptied of its air, turn the handle of the regulator from you again, and the force is upon the surface of the water in P; which surface being only heated by the steam, it does not condense it, but the steam gravitates or presses with an elastic quality like air, still increasing its elasticity or spring till it counterpoises, or rather exceeds the weight of the water ascending in S, the forcing-pipe, out of which the water in it will be immediately discharged, when once gotten to the top, which takes up some time to recover that power; which having once got, and being in work, it is easy for any one that never saw the engine, after half an hour's experience, to keep a constant stream running out the full bore of the pipe. On the outside of the vessel, you may see how the water goes out as well as if the vessel were transparent; for as far as the steam continues within the vessel, so far is the vessel dry without, and so very hot, as scarce to endure the least touch of the hand. But as far as the water is, the said vessel will be cold and wet where any water has fallen on it; which cold and moisture vanishes as fast as the steam in its descent takes place of the water; but if you force all the water out, the steam, or a small part thereof, going through R, will rattle the clack, so as to give sufficient notice to pull the handle of the regulator to you, which, at the same time, begins to force out the water from P, without the least alteration of the stream; only sometimes the stream of water will be somewhat stronger than before, if you pull the handle of the regulator before any considerable quantity of steam be gone up the clack R: but it is much better to let none of the steam go off (for that is but losing so much strength), and is easily prevented by pulling the regulator some little time before the vessel forcing is quite emptied. This being done, immediately turn the cock or pipe Y of the cistern X on P, so that the water proceeding from X through Y (which is never open but when turned on P, but when between them is tight and stanch)—I say, the water falling on P, causes, by its coolness, the steam, (which had such great force just before, from its elastic power, to condense, and become a vacuum or empty space,) so that the vessel P, is by the external air, or what is vulgarly called suction, completely refilled, while P is emptying. Which being done, you push the handle of the regulator from you, and throw the force on P, pulling the condensing-pipe over P, causing the steam in that vessel to condense, so that it fills while the other empties. The labor of turning those two parts of the engine, viz. the *regulator* and *water-cock*, and tending the fire, being no more than what a boy's strength can perform for a day together, and is as easily learned as their driving of a horse in a tub-gin; yet after all, I would have men, and those too the most apprehensive, employed in working the engine, supposing them more careful than boys."

Except stating that an engine raising a column of water, 60 feet high and 3½ inches in diameter, requires a fire-place 20 inches deep, and 14 or 15 inches wide; Savery gives us no information of the proportions of his engines in *The Miner's Friend.* The engraving in that book cannot be depended upon for the correct proportions of the details. The well-known Bradley, who was professor of botany at Cambridge, gives a description of a small engine having only one receiver, erected by Savery himself about 1711, for a Mr. Ball, at Camden-house, Kensington. It was standing in Switzer's time, who says it was the best proportioned of any he had seen. This is represented below:—



The pipe G is 16 feet long, from the surface of the water H to the stage on which the receiver E is placed. And this is the height to which the water is raised by the pressure of the atmosphere. The height of the reservoir above the receiver is about 42 feet; and this column of water was elevated by the elasticity of the steam. The pipe L is 3 inches in diameter, and the steam pipe D about 1 inch bore. The receiver holds 13 gallons, and the boiler 39 gallons.

Its operation is the same as that of the machine shown before; the steam admitted from the boiler B into the receiver E, is condensed by turning the cock M, which allows the cold water to fall on the outside of the receiver, at the same time that the flow of steam from the boiler is shut off by the cock C; a vacuum being thus produced in the receiver, the pressure of the atmosphere raises the water in the reservoir up the pipe G, and fills the receiver E. The cock M is now closed, and the communication between the boiler B and the receiver E is again opened by turning the cock C; the elasticity of the steam then forces the water in the receiver E up the pipe L; the valve at F opening upwards, prevents it from returning. When the receiver is again filled with steam, the cock C is shut, and the cold water or condensing cock M is opened. This condenses the vapor, and forms a vacuum, and the pressure of the atmosphere again acts to raise the water in the reservoir through the pipe G into the receiver, which is forced up the pipe L by the elasticity of the steam, and so on alternately.

Some standard of reference was necessary to give definite information of the effect of this new engine; and Savery introduced the term *horse's power*, which is still in very general use. A certain number of horses were kept to raise a certain quantity of water to a certain height; so a steam-engine, on Savery's construction, was called a one, or a two, or a three-horse engine, as it raised the water which had hitherto been raised by one, or two, or three horses. We have no means of judging of the data he went on in his calculation of the proportions of the several parts of his machines; but from some circumstances, which we shall afterwards notice, it is extremely probable that they were constructed more from tact than calculation.

(To be continued.)

STRATIFIED NON-FOSSILIFEROUS OR PRIMARY ROCKS.

(Resumed from page 339.)

Quartz Rock.—This is a stratified rock the beds of which vary in dimensions, the distinctions between them being more strongly marked than those of gneiss and mica schist, with which it is often associated. It is divided by natural joints, which cause it to break into rhomboidal or rectangular fragments. The variations in its mineral character are numerous; its most simple form is thus described by Dr. M'Culloch:—"It is occasionally, but rarely found in a compact state and crystalline throughout, little differing from quartz, as it occurs in veins, but even in those cases showing a constant tendency to divide in parallel beds. More frequently, when pure, it has an aspect obscurely granular, which, by degrees, becomes somewhat lax and arenaceous, the grains varying in size and in the intimacy of their union. In some of these examples it appears to be a granular crystalline mass; in others it possesses a mixed mechanical texture; while in a third, the rounded aspect of the grains, and the small number of points of contact, appear to indicate an origin chiefly mechanical, and resulting from the agglutination of sand. Cavities are sometimes found in the specimens containing regular, though minute crystals of quartz."

There are other varieties, consisting of quartz intermixed with felspar, and quartz intermixed with mica, forming the passage into gneiss and mica schist, with both of which rocks it alternates, as also with argillaceous schist. The color of quartz rock, when pure, is white, but it occurs of other shades, as ochre-yellow, and red. The presence of mica often produces a grey-colored rock, and a mixture of felspar communicates a flesh-red tint to this compound form of quartz rock.

Argillaceous Schist.—This is a schistose rock, consisting chiefly of indurated clay, varying in hardness, fissility, and composition, and undistinguishable, except by position, from the argillaceoes slates of the lower secondary series. Its essential minerals are the indurated clay which forms the whole of the simple varieties, and quartz and mica, which enter into the compound varieties.* The prevalent colors of the finer kinds are lead-blue, sometimes red and purple, gray and yellow. The green varieties contain chlorite, and pass into chlorite schist.

Crystalline, or Primary Limestone.—A remarkable peculiarity attending the primary strata consists in the very small proportion which the calcareous rocks bear to the rest of the group, thus affording a striking contrast to the secondary rocks, among which carbonate of lime is so largely developed.

Primary limestone is a simple rock, varying from a highly crystalline texture, both large and fine-grained, to compact. It is of various colors, but generally white. The purest and whitest varieties, sometimes called saccharine limestone, from their resemblance in small masses to sugar, are much prized as statuary marble, and are derived chiefly from the celebrated quarries of Greece and Italy.

This rock is generally met with in irregular beds, alternating indifferently with all the members of the primary series. When in contact with granite it is often indurated, and when very impure, is sometimes converted into a cherty substance. When interstratified with gneiss or mica schist, it is apt to acquire so much mica as not to be easily distinguished from those rocks on a laminar fracture.

The members of the primary strata which occur in the greatest abundance, and in the largest masses, are gneiss and mica slate. The series may therefore be conveniently divided into the gneiss and mica schist systems. The former, which is the lowest, consists of strata of gneiss, mica schist, hornblende schist, quartz rock, primary limestone, and argillaceous schist, alternating in no certain order. In the mica schist system, the most quartzose and felspathic portions are found towards the bottom of the system, the most argillaceous portions towards the upper part. The limestone occurs imbedded in the mica schist.

The primary strata occupy a large portion of the surface of the earth. There is scarcely a country in any part of the world in which they are not exposed to view, either by the original absence of the secondary series, or by their denudation or disruption.

They are found in Scotland, Ireland, and part of France; they occupy extensive tracts in Norway, Sweden, and the north of Russia; they constitute the central lines of the Alps, and other mountain-ranges on the continent of Europe, having been brought up from beneath the overlying strata by the subterranean forces which upheaved those chains. They occur extensively in the Brazils, in the United States, and the remotest parts of America which have yet been visited. We know little of the geology of Africa, but they have been found there also. They constitute a large portion of the island of Ceylon; they enter extensively into the composition of the Himalaya Mountains, and are by no means rare in other parts of the continent of Asia. They are indeed so extensively distributed, and, wherever found, appear under such a general similarity of character, that we are justified in assuming that they exist beneath the secondary strata in all parts of the world, and that they have been produced by some general causes acting during the period of their deposition over the whole globe. The nature of those causes has afforded matter for as much controversy as the origin of the unstratified rocks. Werner maintained that they were formed with the world, and were a chemical deposit from "a chaotic fluid," which held their constituents and those of granite in a state of chemical solution. As the waters of this ocean gradually precipitated the minerals with which they were charged, they became capable of supporting animal life, chemical deposits ceased, crystalline rocks were no longer formed, and the secondary strata were deposited, exhibiting entirely a fragmentary structure, and containing the imbedded exuviæ of animals.

Hutton, a Scotch philosopher, contemporary with Werner, propounded a very different doctrine respecting the origin of the unstratified rocks and the primary strata, which has triumphed over the rival hypothesis, and has been confirmed, in its most important points, by the observations of the geologists who succeeded him. He taught that no geological phenomena afford evidence of the beginning of things; that the oldest rocks we behold are derivative, the ruins of pre-existing rocks destroyed by the slow erosion of atmospheric agency, and that their detritus, borne by rivers to the ocean, and loosely deposited over its bed, became afterwards consolidated by heat, and then upheaved and fractured. The crystalline, or primary strata, according to him, were, orginally, mechanical deposits similar to the secondary rocks, but altered by the long-continued action of heat; while granite had crystallized from a state of fusion, and had slowly cooled under great pressure. In support of those views, he and his friends, Playfair and Sir James Hall, collected much of that evidence which we have already adduced as proofs of the igneous origin of the unstratified rocks; and he was himself the first observer of veins ramifying from granite into the superincumbent strata. His delight at witnessing these phenomena exhibited at the junction of the granite with the stratified rocks in Glen Tilt, was so great, that his guides supposed he had discovered a gold mine.

(To be continued.)

ARTIFICIAL CONGELATIONS.

(Resumed from page 341, and concluded.)

The best experiments yet made known on frigorific mixtures, without the aid of snow, are those of Mr. Walker, of Oxford, some of these are as follows:-

Take strong fuming nitrous acid, diluted with water (rain or distilled water is best), in the proportion of 2 parts in weight of the former to 1 of the latter, well mixed and cooled to the temperature of the air, 3 parts; of Glauber's salts 4 parts; of nitrous ammonia 3½ parts,* each by weight, and reduced separately to fine powder. The Glauber's salt is to be first added to the diluted acid; the mixture must then be well stirred, and the powdered nitrous ammonia is immediately to be introduced, stirring the mixture again. The salts should be procured as dry and transparent as possible, and are to be used newly powdered.

These are the best proportions, when the common temperature is 50°. According as the temperature, at setting out, is higher or lower, the quantity of diluted acid must be proportionably diminished or increased. This mixture is little inferior to one made by dissolving snow in nitrous acid; for it sunk the thermometer from 32° to 20°, that is in all 52°. In this experiment 4 parts of diluted acid were used.

Crystallized nitrate of ammonia, reduced to very fine powder, sunk the thermometer, during its solution in rain water, from 56° to 8°; when evaporated gently to dryness, and finely powdered, it sunk the thermometer to 49°. Mr. Walker has frequently produced ice by a solution in water of this salt alone, when the thermometer stood at 70°. If an equal weight of mineral alkali, finely powdered, be added to the mixture, the temperature will be lowered 10° or 11° more.

As it is evident that artificial frigorific mixtures may be applied to domestic purposes, in hot climates, especially where the inhabitants can scarcely distinguish summer from winter by the sense of feeling, it may not be amiss to give a few hints respecting the easiest method of using them.

In most cases, the following cheap one may be sufficient:—Take any quantity of strong vitriolic acid, diluted with an equal weight of water, and cooled to the temperature of the air, and add to it an equal weight of Glauber's salt, in powder. This is the proportion when the temperature, set out with, is 50°; and will sink the thermometer to 5°; if the temperature be higher than 50°, the quantity of salt must be proportionally increased.

The obvious and best method of ascertaining the quantity of any salt necessary to produce the greatest effect by solution, in any liquid, at any given temperature, is to add the salt gradually, till the thermometer ceases to sink, stirring the mixture all the time. If a more intense cold be required, double aqua-fortis, as it is called, may be used. Glauber's salt, in powder, added, will produce very nearly as much cold as when added to diluted nitrous acid. A somewhat greater quantity of the salt is required. At the temperature of 50°, about 3 parts of the salt, to 2 of the acid, will sink the thermometer from that temperature to nearly 0°; and the consequence of more salt being added is, that it retains the cold rather longer. This mixture has one great advantage in its favor; it saves time and trouble. A little water in a phial immersed in a tea-cup full of this mixture will be soon frozen, even in summer; and if the salt be added in crystals, not pounded, to double aqua-fortis, though in a warm temperature, the cold produced will be sufficient to freeze water or cream; but if diluted with one-fifth of its weight of water, and cooled, it will be nearly equal to the nitrous acid before-mentioned, and will require the same proportion of the salt.

A mixture of Glauber's salt and diluted nitrous acid, sunk the thermometer from 70°, the temperature of the air and ingredients, to 10°. The cold in any of these mixtures may be kept up a long time, by occasionally adding the ingredients in the proportions indicated.

Take equal parts of sal ammoniac and nitre, in powder; and cool them by immersing the vessel which contains them in pump-water newly drawn, its temperature being generally 50°. On 3 ounces of this powder pour 4 ounces of pump-water, at the above temperature, and stir the mixture; its temperature will be reduced to 14°, and consequently it will soon freeze the contents of any small vessel immersed in it. The cold may be continually kept up and regulated for any period of time, by occasionally pouring off the clear saturated liquor, and adding more water; taking care to supply it constantly with as much of the powder as it can dissolve. This is a convenient mixture, for if the solution be afterwards evaporated to dryness in an earthen vessel, and reduced to powder, it will answer the purpose as well as at first; as its power does not seem to be lessened by being repeatedly treated in this manner.

All the ingredients employed by Mr. Walker being taken at the temperature of 50°, the following table will exhibit the result of many experiments:—

	Temp
*Sal ammoniac 5, nitre 5, water 16 parts	10°
—— 5, nitre 5, Glauber's salt 8, water 16	4
*Nitrate of ammonia 1, water 1	4
—— 1, soda 1, water 1	7
†Glauber's salt 3, dilute nit. acid 2	3
—— 6, sal ammoniac 4, nitre 2, dilute nit. acid 4	10
—— 6, nitrate of ammonia 5, dilute nit. acid 4	14
Phosphorated soda 9, dilute nit. acid 4	12
—— 9, nitrate of ammon. 6, dilute nit. acid 4	21
†Glauber's salt 8, marine acid 5	0
†—— 5, dilute vitriolic acid 4	3

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* A powder composed of sal ammoniac 5 parts, and nitre 4 parts, mixed together, may be substituted for the nitrate of ammonia.

The salts marked thus (*) may be recovered by evaporating the mixture, and may be used again repeatedly; those marked thus (†) may be recovered for use by distillation and crystallization: the dilute nit. acid was red fuming nitrous acid 2 parts, rain-water 1 part: the dilute vit. acid was strong vitriolic acid and rain-water, equal parts.

By a judicious management, frigorific mixtures, with the aid of snow or pounded ice, mercury even may be frozen into a solid mass. Mr. Walker immersed a half-pint glass tumbler containing equal parts of vitriolic acid, the specific gravity of which was 1·5596, and strong fuming nitrous acid, in mixtures of nitrous acid and snow, until the mixed acids in the tumbler were reduced to −30°: he then gradually added snow, which had been also previously cooled in a frigorific mixture to −15°, to the mixture in the tumbler, stirring the whole, and found, after some minutes, that the mercury in a thermometer immersed in the fluid had become congealed or frozen.

Quicksilver may be congealed by adding newly-fallen snow to strong fuming nitrous acid, previously cooled to between −25° and −30°, which may be easily and speedily effected by immersing the vessel containing the acid in a mixture of snow and nitrous acid.

But the most powerful frigorific mixture yet discovered, is produced by equal parts of muriate of lime and snow. An account of a very remarkable experiment of this kind is given in "Tilloch's Philosophical Magazine," Vol. III. It was performed by Messrs. Pepys and Allen. Into a mixture of equal parts of muriate of lime at 33°, and snow at 32°, a bladder containing no less than 56 pounds of mercury was immersed, after the mixture had liquefied by stirring, and when its temperature was found to be −42°; as soon as the cold mixture had deprived the mercury of so much of its heat that its own temperature was raised from −42° to +5°, the mercury was taken from it, and put into another fresh mixture, the same in every respect as the first. In the mean time, the muriate of lime was kept cooling, by immersing the vessel which contained it into a mixture of the same ingredients: 5 pounds of the muriate were, by these means, reduced to −15°; a mixture being made of this muriate and snow, at the temperature of 32°, in the course of three minutes it gave a temperature of −62°, or 94° below the freezing point of water.

The mercury reduced to −30° by immersion in the second mixture, and suspended in a net, was put into the new-made mixture, and the whole was covered with a cloth to impede the passage of heat from the surrounding atmosphere. After an hour and forty minutes, the 56 pounds of mercury were found solid and fixed. The temperature of the mixture, at this time, was −46°; that is 10° higher than when the mercury was put into it.

Several of those who were present at this experiment having, without attending to the consequences, taken pieces of the frozen mercury into their hands, experienced a painful sensation, which they could compare to nothing but that produced by a burn or scald, or by a wound inflicted with a rough-edged instrument. The parts of the hand which were in contact with the metal lost all sensation, and became white, and to appearance dead: a phenomenon which alarmed the sufferers not a little: however, soon throwing away the pieces from them, as they would have done hot coals, the injury scarcely penetrated the skin; and in a little time the parts, by friction, resumed their usual sensation and color.

The late Professor Leslie devised an elegant method of reducing the temperature sufficiently low to freeze water in any climate, and at any season of the year. His method is shortly this: under the receiver of an air-pump, place one vessel containing sulphuric acid, and another containing a small quantity of water. The air being partly withdrawn from the receiver by the air-pump, vapor is raised abundantly from the water, and absorbed by the acid. Thus a degree of cold is produced which freezes the water in a very short time.

A saucer of porous earthenware is best adapted for holding the water, and instead of sulphuric acid, other absorbents may be used, such as parched oatmeal, the powder of mouldering whinstone, or the dry powder of pipe-clay.

Mr. Leslie placed a hemispherical vessel of porous earthenware, containing a pound and a quarter of water, over a body of parched oatmeal, one foot in diameter and one inch deep; and by working the pump for some time, the whole of the water was frozen.

(*To the Editor.*)

SIR.—Having made some experiments with a view of discovering a cheap and good bronze for electrotype medals, and having been fortunate enough to hit upon a process which produces one like the tea-urn bronze, I forward it to you, requesting you will be pleased to insert it in your Magazine for the benefit of those engaged in electrotypical pursuits.

Thoroughly clean the medal and also polish; make a thick paste with urn powder and water, and apply this with a brush equally over the surface of the medal. When dry, place it over a clear fire in the kitchen fire-shovel for about a minute, more or less, according to the depth of shade required; and when cool, polish with a plate brush.

The urn powder may be bought at any of the polishing powder manufacturers.

Common rust of iron may be substituted for the urn powder, it produces a similar bronze, although of a different shade. HENRY COX.

January 14, 1842.

(*To the Editor.*)

SIR.—Since reading in your excellent Magazine an account of Mr. Wagstaff's air-pump, the following plan has occurred to me, which I think would be an improvement on his, viz.:—

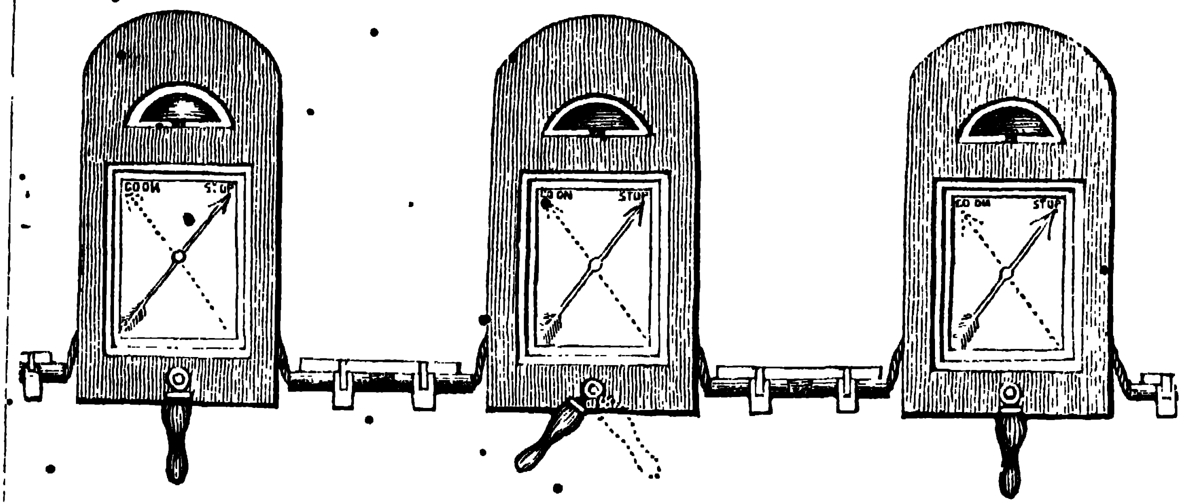
To place the cylinder horizontally, to have two taps or valves, one at each end of the cylinder, and to make the piston-rod work through a stuffing box.

The advantages of this arrangement are these, that air would be extracted at each stroke of the piston, and the machine itself would occupy less room. The valves may be opened and shut at the proper moment by any one of the various contrivances used in modern steam-engines for that purpose

If you consider this suggestion worthy of notice, I shall feel honored by your inserting it in your Magazine. W. B. P.

Langport, Somersetshire,
January 19, 1842.

Fig. 1.



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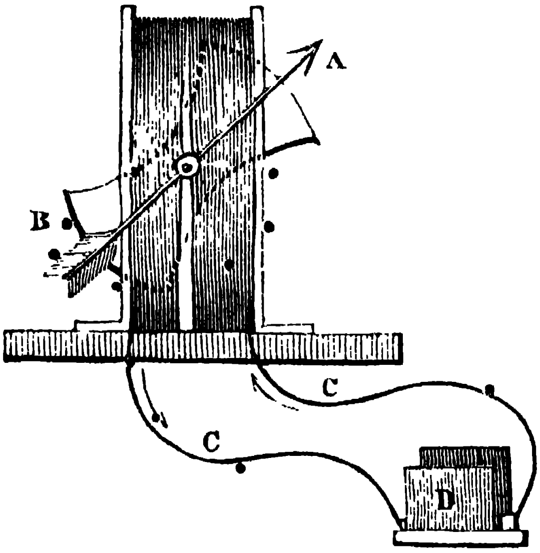

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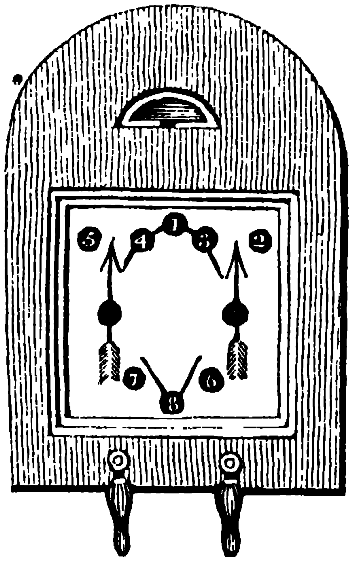
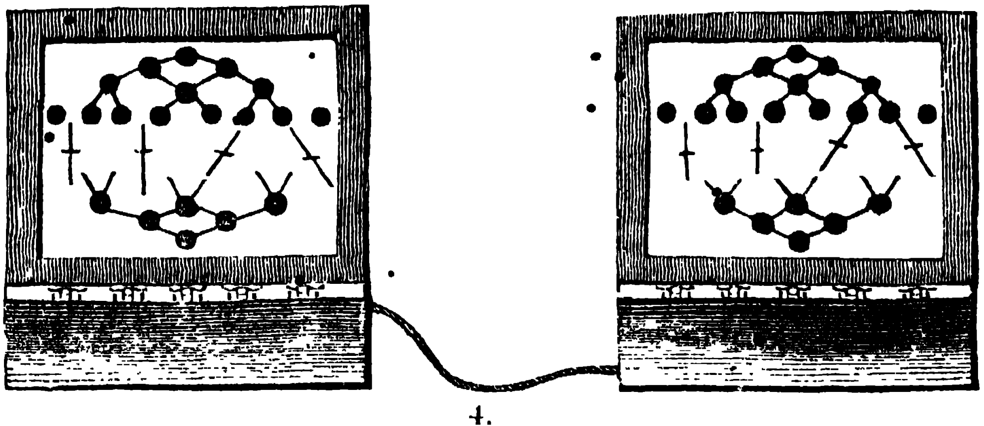


TELEGRAPHIC RAILWAYS.



4.

Telegraphic Railways: or, the Single Way; recommended by Safety, Economy, and Efficiency, under the Safeguard and Control of the Electric Telegraph. By W. F. Cooke, Esq.—(Simpkin and Marshall.)

A LITTLE work under the above title has just made its appearance, and when we mention that its author is the same Mr. Cooke, who was the coadjutor of Professor Wheatstone in the invention and establishment of the electrical telegraph, it will be sufficient to call attention to his work.

The author states that he seeks two objects:—the first is to add to the safety and efficiency of railway communication, by means, not more, but less expensive than those now adopted. The second is, to overcome some objections to the formation of auxiliary single lines, by suggestions calculated to give them the safety and efficiency now supposed to be exclusively within the reach of double lines. He proposes to accomplish these objects by the *electric telegraph*, the object of which is clearly explained in the subjoined statement. The first of these points, whether a single line of railway would be equally safe, rapid, and efficient to the double rail now established, we will not pretend to offer an opinion upon, not being an engineer; but the peculiar advantages of the electric telegraph in conveying information along a line with instantaneous rapidity, is certainly within the legitimate objects of science, and one which we are very happy to illustrate; indeed, we had prepared an article upon it, but which we willingly cancel in order that its originator may himself exhibit its advantages. The following is an extract from this valuable and original work:—

"In considering the electric telegraph as a most desirable, if not indispensable guardian of railway travelling on an extended scale, I am borne out by the opinions of many of the first practical men cognizant of the subject—by the successful experimental application of the telegraph to a part of the Great Western railway—the judgment of a Parliamentary Committee—and the hourly experience of that most masterly work, the Blackwall railway.

"It is well known that on the Blackwall railway the carriages on each line are moved by what is called 'a tail-rope,' to which they are attached, and which is almost incessantly being drawn along the line, to be wound up on a drum at one terminus or the other, by the alternate action of the stationary engines. It is consequently necessary that, before the engine-man applies the power of his engine to the rope for the purpose of giving motion to a train, he should have received a specific intimation from every other station that its carriage is attached to the rope, and ready to start: otherwise an independent and uncontrolled motive power, acting from the terminus, would frequently cause dreadful collisions among carriages placed at stations so nearly adjacent as those at Shadwell, Stepney, Limehouse, the West India Docks, and Poplar.

"It is also necessary that the most perfect understanding should exist between the breaksman at one terminus, and the engineman at the other, as a very skilful adjustment of the quantity of rope released is requisite to preserve the rope from injury. In a word, the condition of starting a train is, that the telegraph at the terminus to which it is going should express that the carriages at the six other stations are ready; and finally, that the breaksman at the starting terminus, (on whose signal, in fact, the starting depends,) is ready also. The operation of stopping is still more delicate in its character and consequences; for, if the engine-man were to turn off his steam before the breaksman at the other terminus had begun to apply his break. the rope must suffer from overslackness; or, if the breaksman were to put on his break while the engine at the distant terminus was still exerting its full power, it might be broken by the excessive strain. Even the ordinary stopping of a train could not be effected without danger to the rope; and an unexpected stoppage (now a matter of ordinary occurrence and perfect facility, even at full. speed) would, without a telegraph, be attended with certain injury.

"On a railway which despatches a series of trains in each direction every quarter of an hour, and has stations within a few hundred yards of each other, (not again to dwell upon the circumstance of a distant and independent motive power,) accidental derangement would be more serious in its consequences, and of more frequent occurrence, if not prevented by the telegraph, than on any ordinary line. Now, in point of fact, millions of passengers have been carried in safety upon the Blackwall railway, during the 18 months which have passed since the line opened, in upwards of half a million of carriages, starting and stopping independently of each other; and this through the intervention of a system of telegraphs, commanding only from two to eight signals each, and worked by lads, or porters, or breaksmen, performing regularly their ordinary duties.

"Here, then, the electric telegraph may be seen in daily operation, with the most beneficial effects. If an accident occur, the telegraph renders it harmless: a carriage, perhaps, loses its 'grip' of the rope, and gives a signal of distress; the porter at the nearest station transmits a telegraphic order to stop the engine working that line; and within two or three minutes the train is again in motion, without alarm to the passengers, or interference with the working of the other line. By enabling persons at distant stations to converse with the speed (literally) of lightning, it substitutes a known certainty for an inferential probability of safety, or danger.

"To a system so nicely adjusted, but liable to such sudden interferences, as that of the Blackwall railway, the best time-table would be evidently inapplicable. If, then, under circumstances of such extraordinary difficulty and complication, the electric telegraph, in the hands of ordinary workmen, performs its duties in the most perfect manner, it is a necessary consequence, that it is capable of dispensing its benefits with equal certainty, where those duties would be incomparably less arduous.

"The principles on which the electric telegraph is constructed, are founded on Oërsted's celebrated discovery, that a magnetic or compass needle may, through the agency of a voltaic current, be invested with an artificial polarity. Thus, as a natural stream of electricity, passing round the circumference of the earth, causes magnetic needles in general to be deflected at right angles to its course, or towards the north and south poles; so an artificial stream of electricity, of adequate strength, will cause magnetic needles, placed within its influence, to be similarly deflected at right angles to *its* course, whatever that may be. If, then, a magnetic needle were placed parallel, and near, to any part of a conducting wire, which we will suppose to be laid down between London and Blackwall, the transmission of an electric current from a voltaic battery would cause the needle to change its position, so as to stand, during the continuance of the current, at right angles to the wire; being turned in one direction or the other according to the course of the current. If this deflexion of the needle were limited by two fixed stops, placed respectively at the two sides of one of its poles, the motion of that pole to one stop might evidently constitute one signal, and its motion to the other stop, another signal.

"Fig. 1 represents some of the Blackwall railway instruments, constructed upon the principles above explained. The signals are given by pointers, each suspended vertically on an axis, moving freely through the face of a dial. Behind the dial a magnet is fixed on the same axis as the pointer, so that both move together, as is seen in Fig. 2, where A B is the magnet and pointer; C C the conducting wires of the coil; and the galvanic battery. A portion of the conducting wire is coiled many times longitudinally round a frame in which the magnet moves, so as to subject the magnet to the multiplied deflecting force of the voltaic current. The motion of the magnet is limited at both sides by fixed stops. Now, suppose three of these very simple instruments, included in the same conducting wire to be placed, one at the Minories, a second at Blackwall, and the other at some third point. The general effect of this arrangement would be, that the transmission of electricity along the conducting wire, and therefore through the convolutions of wire surrounding the respective magnets, would deflect those magnets with a sudden and decided motion to one of the stops, and cause the exterior pointers to indicate corresponding and simultaneous signals upon the dials of the three instruments. Each instrument is provided with a battery; and a handle, by which a porter or policeman is enabled at pleasure to connect the conducting wire with his battery. By moving the handle to the right or left, either of the signals can be instantaneously transmitted from any one of the instruments to all the others; which, by means of their own handles, have the power of sending back signals in reply: correctness being ensured by the simultaneous appearance of the signal in the instrument of the operator, and that of the recipient. The transmission of intelligence is prefaced by sounding a bell till attention is obtained; an operation effected through the agency of the voltaic current." [The method of this was described in Vol. I.—ED.]

"Fig. 3 represents one of the instruments upon the Edinburgh and Glasgow Railway, being a combination of two of the above elementary telegraphs. Each needle is here worked by its distinct handle. By the single movements of the pointers, the figures 2, 3, 4, and 5, may be given. If the two pointers are made to converge upwards at the same time, their combined indication will be the figure 1; or if they converge downwards, 8. If the pointers are made to rest diagonally parallel to each other in one direction, 6, in the other, 7 is indicated. Eight distinct signals are thus obtained, which, in connexion with a code, are sufficient for all ordinary purposes. By combining several elementary telegraphs any number of signals may be obtained. A drawing of the telegraph employed on the Great Western railway, worked by keys, and having a peculiar arrangement of the conducting wires not necessary to be explained, is subjoined to illustrate this point." [This is represented in Fig. 4.—ED.]

"The apparatus which I arranged upon the Great Western railway enabled me to submit the electric telegraph to the test of experience to the extent of 78 miles of wire, equal to a stage of 39 miles, nor did I see any reason to doubt its capability of working for much greater distances, without intermediate stations. The scientific investigations of my coadjutor, Professor Wheatstone, tend to the same conclusion; and I may observe, though not to my present purpose, that our latest improvements have enabled us to carry on the most complete and extensive correspondence with only two or three wires."

After the author has thus described his very ingenious instrument, he proceeds to give his plan for a telegraph railway, and to illustrate its efficiency under the unusual circumstances of an express train. The impediment of ballast waggons—of permanent obstructions—and crossing of two trains—and very numerous other important matters, which, although of the first importance to the general subject, it would be irrelevant for us to introduce. We trust, however, that this slight notice will induce inquiry for a book, which, small as it is, contains much that is original and valuable.

OBTAINING IRIDIUM AND OSMIUM.

THE black pulverulent residue which remains after the solution of native platinum in aqua regia, contains, besides the combination of osmium and iridium, a considerable quantity of free iridium, and some iron and titanium. Wöhler recommends the following process for separating them:—Mix equal portions of the residue and decrepitated common salt, and place them in a green glass tube, which is to be passed through a tube furnace similar to that in the apparatus of Liebig. To one end is fixed an apparatus for the production of chlorine, and the other communicates with a vessel filled with ammonia, preceded by a bulb for the absorption of the oxide of osmium. Under the tube hot coals are to be placed, in order that the mixture contained in it, which should occupy three-fourths of its diameter, may be exposed to a strong heat. The chlorine is then allowed to pass through the tube. By this operation sodium-chloride of iridium, and sodium-chloride of osmium are formed, both of which salts are soluble in water, while the titanium remains insoluble. A little chloride of osmium will be formed in the first portion of the tube. The greater portion of the oxide of osmium will have crystallized in the bulb situated at the extremity of the tube. The bulb is to be exposed to a heat so as to melt the oxide, and in this state it may be poured into a flask or glass tube. The tube may be placed on one side, so as to allow the oxides to sublime in the form of long crystals on the opposite side.

To the ammonia, which contains more or less oxide of osmium, and is colored yellow by it, let some sal-ammoniac and carbonate of soda be added, and let the whole be then evaporated to dryness, and heated to redness in a glass retort. By this method the oxide will be reduced to the metallic state, which, by treating with water, will remain in the form of a black powder. It is then washed and dried. The oxide in the bulb may be reduced in the same manner after it has been dissolved in ammonia.

When the tube with its contents is placed in a cylindrical vessel full of water, all the soluble portion dissolves. A deep brownish red solution of double salt of iridium is formed. The liquid after standing should be decanted from the residue, which consists of titanium, and some pieces of osmium and iridium. The fluid drawn off is distilled to separate the oxide of osmium, which may still exist in it. When the whole of the acid has passed over, the distillation is stopped and the solution filtered. It is then to be evaporated over a fire, and during the concentration, carbonate of soda is be added in excess, which throws down a blueish black precipitate.

The dried black mass will then be strongly heated in a Hessian crucible, and after cooling, be digested in water. The residue is a sesquioxide of iridium. The filtered salt solution contains, besides common salt and carbonate of soda, also chromate of soda, which gives it a yellow color.

The sesquioxide of iridium contains, besides osmium, some oxide of iron. It is to be placed in a glass tube, and hydrogen passed over it at a red heat till water ceases to be formed. Metallic iridium thus obtained is a black powder. It contains much caustic soda, which was chemically combined with sesquioxide, and is now taken up by water. By digestion in muriatic acid the iron is removed. After washing, it may be placed between layers of filtering paper, and pressed for several hours with a screw press. Heated then in a crucible, it is obtained in the form of a firm polished grey mass. Metallic iridium may be obtained by a shorter method, but not in such purity; by evaporating the solution of sodium-chloride of iridium to dryness, heating to redness, so as to melt the salt, and begin to volatilize the chloride of sodium. The iridium will thus be reduced, and remain, after digestion in water, as a grey or black metallic powder.

SPEAKING AND HEARING TRUMPETS.

As the sight is assisted by telescopes and microscopes, so similar instruments have been contrived for assisting the faculty of hearing. One of these, called the speaking trumpet, is employed for conveying sound to a great distance: the other, called the ear-trumpet, serves to magnify to the ear the least whisper.

Among the moderns, Sir Thomas Moreland bestowed the most labor in endeavouring to improve this method of enlarging and conveying sound, and on this subject he published a treatise, entitled "De Tuba Stentorophonica," a name which alludes to the voice of Stentor, celebrated among the Greeks for its extraordinary strength. The following observations on this subject are in part borrowed from that curious work.

The ancients, it would seem, were acquainted with the speaking trumpet: for we are told that Alexander had a horn, by means of which he could give orders to his whole army, however numerous. Kircher, on the authority of some passages in a manuscript, preserved in the Vatican, makes the diameter of its greatest aperture to have been seven feet and a half. Of its length he says nothing; and only adds that it could be heard at the distance of 500 stadia, or about 25 miles.

This account is no doubt exaggerated; but, however this may be, the speaking trumpet is nothing else than a long tube, which at one end is only large enough to receive the mouth, and which goes on increasing in width to the other extremity, bending somewhat outwards. The aperture at the small end must be a little flattened to fit the mouth; and it ought to have two lateral projections to cover part of the cheeks.

Sir Thomas Moreland says, that he caused several instruments of this kind to be constructed of different sizes, viz. one of 4½ feet in length, by which the voice could be heard at the distance of 500 geometrical paces; another 16 feet 8 inches, which conveyed sound 1800 paces; and a third of 24 feet, which rendered the voice audible at the distance of 2500 paces.

To explain this effect, we shall not say, with Ozanam, that tubes serve, in general, to strengthen the activity of natural causes; that the longer they are the more this energy is increased, &c.; for this is not speaking like a philosopher; it is taking the effect for the cause: we must reason with more precision. The cause of this phenomenon is as follows:—

As the air is an elastic fluid, so that every sound produced in it is transmitted spherically around the sonorous body; when a person speaks at the mouth of the trumpet, all the motion which would be communicated to a spherical mass of air, of 4 feet radius for example, is communicated only to a cylinder, or rather cone of air, the base of which is the wider end of the trumpet. Consequently, if this cone is only the hundredth part of the whole sphere of the same radius, the effect will be as great as if the person should speak a hundred times as loud in the open air; the voice must therefore be heard at a distance a hundred times as great.

The ear trumpet, an instrument exceedingly useful to those almost deaf, is nearly the reverse of the speaking trumpet; it collects, in the auditory passage, all the sound contained within it; or it increases the sound produced at its extremity, in a ratio which may be said to be as that of the wide end to the narrow one. Thus, for example, if the wide end be 6 inches in diameter, and the aperture applied to the ear 6 lines, which in surfaces gives the ratio of 1 to 144, the sound will be increased 144 times, or nearly so; for we do not believe that this increase is exactly in the inverse ratio of the surfaces; and it must be allowed that, in this respect, acoustics are not so far advanced as optics.

The tube of the ear trumpet is now often made of India-rubber, covered with an ornamental network. It is made of considerable length, and being flexible, the wearer can converse with a person across a table by passing over the end to which the mouth-piece is attached, and applying the other end to his ear.

It is a certain fact, proved by experience, whatever may be the cause, that sound confined in a tube, is conveyed to a much greater distance than in the open air. Father Kircher relates, in some of his works, that the laborers employed in the subterranean aqueducts of Rome, heard each other at the distance of several miles.

If a person speak, even with a very low voice, at the extremity of a tube, some inches in diameter, another, who has his ear at the extremity, will hear distinctly what is said, whatever be the number of the circumvolutions of the tube.

This observation is the principle of a machine, which excites great surprise in those unacquainted with the phenomena of sound. A bust is placed upon a table; from one or each of its ears a tube is conveyed through the table and one of its feet, so as to pass through the floor, and to end in a lower or lateral apartment. Another tube, proceding from the mouth, is conveyed in a similar manner, into the same apartment. A person in company is desired to ask the figure any question, by whispering into its ear. A confederate of the one who exhibits the machine, by applying his ear to the extremity of the first tube, hears very plainly what has been said; and placing his mouth at the aperture of the other tube, returns an answer, which is heard by the person who proposed it. If motion be communicated at the same time to the lips of the machine, by any mechanical means, the ignorant will be much surprised, and inclined to believe that this phenomenon is the effect of magic. It may be easily seen, however, that the cause is very simple.

TAR AND PITCH.

Tar, which is so extensively used for naval purposes, may be classed with the impure empyreumatic oils. It is distilled from the wood of the fir-tree, and produced in large quantities in the north of Europe and in North America. We receive it from Russia, Sweden, and America; that coming from Sweden being considered the best, and commanding the highest price.

Great part of that which is manufactured in America is made from old fir-trees, which have fallen down in the woods, and have their sap no longer fluid. This is what is called light-wood, not with reference to its weight, as it is very heavy, but from its combustible nature, readily igniting and burning with so bright a flame as to serve the office of a candle. Only one particular species of pine (*pinus palustris*) become light-wood. Persons concerned in making tar immediately know it from the appearance of the concrete juice in the grain of the wood. When fir-trees are to be cut down for this purpose, those are most esteemed whose branches are distorted and full of knots; the sap which is thereby retarded in its circulation depositing a better kind, as well as a greater quantity of the resinous matter from which tar is distilled. Old trunks of trees, which have remained in the ground many years after their branches have been cut off, are likewise rich in that material. But the surest and best method of obtaining the greatest quantity of tar-wood, is to strip off the bark and branches in the spring, from such firs as are destined for this purpose, and to leave them in that state until the year following. They should then be felled, and cut into small pieces as if for fagots. Being well dried, those billets which appear most oily and resinous are separated from the rest and alone reserved for use; two-thirds or more of the tree will be thus retained, provided it was in a state of proper maturity previously to the stripping of the bark, and that after this operation it had been left sufficiently long in the ground. This is called tar-wood. The wood of the trees from which turpentine has ceased to flow is likewise made to yield tar. The faces over which the juice has flowed and partially concreted are split off, and from these is made what is called green tar, because distilled from green wood instead of dry.

When a sufficient quantity of wood is collected, a circle is marked out on the ground for the kiln. The earth is then dug out a spade deep, sloping from the centre to the circumference, and is thrown up forming a bank round the circle. A straight pine, of sufficient length to reach from the centre some way beyond the bank, is split longitudinally and hollowed out. The parts are then put together again and one end is placed in the centre, being so supported on the ground that this end is higher than that which comes without the bank, where a hole is dug into the ground, into which the tar flows from the channel, and whence it is from time to time taken out and barrelled for market without any farther preparation.

After the kiln is marked out, the wood, being split up in small billets, is packed as close as possible, with the inward ends sloping towards the middle, which is filled up with smaller pieces, consisting of the knots of the trees, these yielding more tar than any other part of the wood. The kiln is built in such a manner, that at twelve or fourteen feet high it will overhang two or three feet, and appear quite compact and solid. After the whole of the wood is piled, a number of small logs are placed round it, then a layer of turf, and so on alternately throughout the whole height; the top is then covered over with two or three layers of turf. After the whole is thus arranged, a turf is taken out in ten or twelve different places round the top, at each of which parts fire is applied, and the pile then burns downwards, till the whole of the tar is distilled from it. If combustion proceeds too rapidly, some of the holes must be stopped up,—if too slowly, others should be opened; practice enables a tar-burner to judge with tolerable accuracy as to the best measures to be pursued in this respect. Six or eight days are generally required to complete the burning of a tar-kiln of the dimensions here described.

Another method pursued is to place the tar-wood in a receptacle inclosed by an arch and walls, a small opening only being left near the bottom for the egress of the tar: a fire is then made round the arch in such a manner that the heat may communicate to the inside, and cause the tar to be distilled from the wood in the same way as if retorts had been used. This plan is perhaps more expensive than the first, and therefore less generally practised; the operation is, however, performed in much less time, and the quantity of tar produced from a given quantity of wood is greater than that obtained by the other method, while a very superior kind of charcoal is at the same time afforded from the wood thus carbonized. In the common way a cube of six feet of tar-wood yields from two to three, and sometimes four tuns of tar: burnt by this last described method, the same bulk of wood produces, in half the time, five or six tuns. An equal quantity of common fir-wood yields only about one tun, or one tun and a half.

In Norway, and other countries bordering on the Baltic sea, where the vast extent of their pine forests induces the natives to be less economical in the use of the wood, stacks of it are built on the slope of a hill, and covered with moss and turf: fires are then kindled in different parts; and the tar which oozes out flows through channels or spouts into barrels placed for the purpose at the bottom of the hill.

A more economical process for making tar is pursued in France and Switzerland, by which the wood is charred more equably, and the product is of a much more uniform, and probably also of a better quality. In the Valais the pines are felled the preceding year, that the wood may be sufficiently dry for use; and the outer bark and twigs being stripped off, the rest of the tree is cut up into billets of tolerably equal size. An oven is built of stone or brick in the form of an egg standing on its small end. On one side, about five inches from the lowest point, an aperture is made into which a tube is inserted. A large iron grating is laid at the bottom just above the opening for the tube, and on this the billets of wood are piled. This grating prevents the passage of any pieces of wood or other impurities, which would otherwise run out together and mix with the tar. The oven being filled with wood, a layer of dry chips is placed at the top, and the whole is inclosed, leaving only an aperture at the summit to act as a chimney: the chips are then kindled, and when the fire has spread downwards, and the whole is sufficiently ignited, the chimney is entirely closed with a large stone, and wet earth is heaped on this, more being thrown on whenever the smoke bursts out too strongly. The general average product thus obtained is about ten or twelve per cent. of the weight of the whole charge.

The common method, as pursued in the north of Europe, though the least expensive of all, is attended, however, with great inconveniences. The management of the fire is extremely difficult and precarious, so that scarcely any workmen, who have not been long used to conducting the process, can be safely trusted with its superintendence, and the success even of these does not always answer their expectation. A much smaller quantity of tar is always extracted in this manner than that produced from an equal quantity of wood distilled in furnaces. The process by furnace is therefore always preferred by those tar-burners who have the means of pursuing it.

Pitch, which is condensed tar, is obtained either by evaporation or burning. The process of burning is performed very simply. A hole is dug in the ground and lined with brick: it is then filled with tar, which is ignited and allowed to burn till the pitch is judged to be of sufficient consistency, which is ascertained by dipping a stick in it, and allowing the pitch adhering to it to cool. When sufficiently burnt, the hole containing the pitch is closely covered, and the atmospheric air being thus excluded, combustion ceases. Five barrels of green tar are thus concentrated to two barrels of pitch, and two barrels of other tar make one of pitch.

When pitch is evaporated in kettles it requires to be almost constantly stirred. The country people in Sweden, when they have no kettle for boiling their tar, in order to reduce it to pitch, put it into great wooden pails: into these pails they throw very large stones previously heated; the stones keep the tar almost boiling, and this process is continued until the fluid is of sufficient thickness.

A portion of the tar imported into this country is converted into pitch; the establishments for this purpose near London are conducted on a much more economical plan than that pursued abroad. Here no part of the tar which has any useful property is allowed to be wasted. It is evaporated in a still, and, consequently, the valuable volatile products are condensed and preserved. The oil, and acid and water, which distil over, do not mix, and may be easily separated by further distillation. The oil is an inferior oil of turpentine, which is useful in coarse painting. The acid is strong and empyreumatic, very closely resembling the pyroligneous acid obtained from the distillation of wood. By this method of converting tar into pitch, 600 gallons or 20 barrels of tar, will produce 10 barrels or 2,200 weight of pitch, 176 gallons of oil, and about 40 gallons of acid.

LIGHTHOUSES.

The ancient mode of exhibiting lights as beacons to the mariner consisted in burning wood or coal in a chauffer on the top of a tower; and till the year 1807, the Eddystone light was nothing better than the feeble blaze of a few tallow candles, without any apparatus for concentrating the light or giving it any particular direction. But as rays of light proceeding from a luminous focus are equally dispersed over the surface of the sphere which has the focus for its centre, it is evident that without some means of giving the light a horizontal direction, the greater part of it must be wholly lost; for only those rays which are directed in the plane of the horizon, or at least which are depressed only a few degrees below it, can be seen by a ship at a distance. Hence the first object to be attained is to prevent the loss of light by throwing the whole of it forward in the plane of the horizon, in order that its intensity may be increased in the greatest possible degree. Now there are two principles on which this may be accomplished, reflexion and refraction. The object is accordingly carried into effect by a catoptric or dioptric apparatus. Sometimes both principles are combined in the same apparatus.

Catoptric System.—The usual mode of applying the catoptric principle is by burning an Argand lamp in the focus of a parabolic mirror. This mode of illumination appears to have been first carried into effect at the Carduan lighthouse, under the direction of Borda, about the year 1780. A few years later reflecting mirrors were placed in some of the English lighthouses, under the direction of the Trinity House; and in 1786 the principle was adopted in the only two beacons then existing on the coast of Scotland; viz. the Isle of May in the Firth of Forth, and the Cumbrae Isle in the Clyde. Soon afterwards it was adopted generally in this country. Borda's reflector was formed of a sheet of copper plated with silver; those applied in Scotland were formed of small facets of mirror glass, placed in hollow parabolic moulds of plaster. The mirrors in general use in the British lighthouses at the present time are of copper lined with silver; the focal length is about 3 or 4 feet, and the diameter at the outer edge about 21 inches.

If the curvature of a reflector could be made truly parabolic, and if the light issued from a mathematical point, the rays would be reflected from the mirror exactly parallel to the axis of the generating curve, and the beam of projected light would be a cylinder having a diameter equal to that of the mirror. Such a form of the beam would render the light nearly useless, on account of the small portion of the horizon which would be illuminated; and it is accordingly necessary to give the rays a certain degree of divergence: this is practically effected by the size of the flame. The burner of the lamp is usually an inch in diameter; and the origin of the luminous rays being thus at a small distance from the focus, instead of being reflected parallel, they are projected in a cone having a divergence of about 14°. The curvature of the mirror may also be so adjusted as to increase the divergence.

In order to produce a light of sufficient intensity, several parabolic mirrors, sometimes as many as eight, are placed on a frame, with their axes all parallel to each other, so that the light reflected by all of them is blended together in the same beam. To form a revolving light, the frame is attached to a horizontal axis, which is turned by means of clock machinery; and in this manner the different quarters of the horizon are successively illuminated. But as a rapid motion would be inconvenient, the frame has usually three or four sides, on each of which the same number of mirrors and lights is placed; so that the illumination is repeated three or four times in one revolution. To form a stationary light, a number of reflectors are placed round a circular frame, having their axes on the radii of the circle. This arrangement has one obvious defect; namely, that the illumination will not be equally intense at all azimuths, but strongest in the direction of the several axes, and feeblest in the direction of lines bisecting the several angles formed by each pair of contiguous axes. The defect is one which cannot be entirely remedied in a stationary light on the catoptric principle.

Dioptric System.—The introduction of lenses for the purpose of giving the light a horizontal direction is of recent date. A project for this purpose is indeed mentioned by Smeaton in his account of the Eddystone lighthouse, and about the end of the last century the method was tried at some lighthouses in the south of England; but from the imperfect figure of the lenses, and the absorption of the light caused by the great thickness of the glass, it did not succeed. But the art of grinding spherical lenses having been since brought to greater perfection, and a means of greatly diminishing the absorption, and also of constructing lenses of a much greater size, having been found in the use of polyzonal lenses, (that is to say, lenses formed of several pieces separately prepared and afterwards united,) the system has been revived of late years, and, in many instances carried successfully into execution. The merit of first applying such lenses to lighthouses belongs to the late Auguste Fresnel, of the Academy of Sciences of Paris. The annular lenses, constructed under the direction of Fresnel, for the principal lighthouses in France, are plano-convex, having a focal distance of about 3 feet; and they are formed of crown glass, as being less liable to *striæ* than flint glass. The effective divergence of the cone of light projected by a lens is generally less than in the case of a paraboloidal refractor, being only about 5° 9′. As the luminous cone is formed of only that portion of the light which falls on the surface of the lens, it might be supposed that an apparatus of this kind would be far inferior in its effect to a parabolic mirror; but when it is considered that, owing to the imperfections of the form and polish of the reflecting surface, more than one-half of the incident light is lost in every case, and also that a larger and more intense flame may be used for illuminating the lens than can be applied to a parabolic reflector, it will easily appear that the superiority may be on the side of the lens. In fact, a lens of the largest size used in the French lighthouses projects a cone of equal intensity to that of eight mirrors of the best kind.

The construction of a revolving dioptric apparatus of the first order is usually as follows:—The revolving frame which carries the principal lenses has eight sides; and there are consequently eight large lenses, so arranged that their axes are all in the same horizontal plane, and meet in the common focus, where the lamp is placed. This frame, with its lenses, consequently forms an octagonal prism. For the purpose of preventing the loss of the rays which fall above and below the principal lenses, various methods are employed. One is to place above the first frame a second frame, whose sides form the frustum of an octagonal pyramid of 50° of inclination, in each of the sides of which is placed a lens having its focus in the flame of the lamp. The rays falling on these inclined lenses are refracted into directions parallel to the axis of the lens, and are then reflected into the horizontal direction by plane mirrors placed above the second frame. Another method is to place curved reflectors above the frame containing the principal lenses. But a third and still more elegant method, proposed by Fresnel, is to substitute for the upper lenses and mirrors a series of triangular prisms, having their axes arranged in horizontal planes, and so adjusted that the light falling on the face next the flame is thrown upon the back of the prism, where it suffers a total reflexion; and a second refraction at the third side of the prism gives it the horizontal direction.

For fixed lights on the dioptric system, it is necessary to increase the number of the lenses, which in fact ought to be infinite, or to form a true cylinder, in order to produce an equal diffusion over every point of the horizon. In some of the French lighthouses the refracting apparatus consists of a polygonal belt of thirty-two lenses; but on establishing a dioptric apparatus at the Isle of May lighthouse, in 1836, Mr. Alan Stevenson proposed to form a true cylindric belt; and the task, though attended with much difficulty, was successfully executed at a glass-house in Newcastle.

The dioptric system is peculiarly adapted for fixed lights; and its advantages are these:—1. A light of equal intensity is distributed round every point of the horizon. 2. The consumption of oil is less for the same intensity of light, and consequently the expense of maintaining the light is less. 3. The trouble attending it is less, as there is only one lamp to trim, and the lenses are easily kept in order; whereas the reflecting surfaces require much care and attention. On the other hand, there is more risk from accident, for the accidental extinction of the lamp leaves the whole horizon in darkness; whereas in a system of reflectors the light would be extinguished over only a small portion of it.

Fresnel published his first memoir on the subject in 1822; since that time the dioptric system has been generally adopted for all the principal lighthouses of France and Holland. In this country it has as yet been applied only at Inchkeith and the Isle of May in the Firth of Forth, and at the Star Point in Devonshire.

Lamps.—For the lights on the catoptric system, the illumination is usually produced by an Argand fountain lamp, having a burner of an inch in diameter, and tipped with silver, in order that it may the better withstand the effect of the heat evolved. In the dioptric system a larger flame is requisite; and Fresnel invented a lamp, the peculiarity of which consists in its having a series of concentric burners. For lights of the first class the number is four; and they are protected from the effects of the excessive heat by a superabundant supply of oil, which is thrown up from the cistern below by a clock-work movement, and is kept constantly overflowing the wicks. A tall chimney is necessary to supply a sufficiency of air. In this country the lamp is fed with spermaceti oil; in France the oil of colza (expressed from the seed of the wild cabbage,) is used; and in some parts of the Mediterranean olive oil, but the light obtained from this is comparatively feeble. In a few instances coal gas has been used for dioptric lights. All attempts to apply the Drummond light, and voltaic lights, have failed, by reason of the great practical difficulties with which those modes of illumination are attended.

Method of distinguishing Sea Lights.—An object of great importance in the establishment of light-houses is to vary the appearances of the different lights, so that each may have some distinctive character by which it may be readily recognized, and the mariner be made aware of the part of the coast he is approaching. Among the methods adopted for this purpose are the following:—1. The interposition of colored shades before the lenses or refractors, so as to give a particular color to the light: red is the only color which can be used, as shades of any other color are found to absorb too much light. 2. The time of revolution, or the length of the interval between the successive appearances of the light: this is the only mode of distinguishing lights adopted on the French coasts. 3. A *flashing light;* that is, a light of which the alternate flashes and eclipses succeed each other so rapidly as to give the appearance of a succession of brilliant scintillations. 4. An *intermittent light,* which consists of a fixed light which is suddenly eclipsed, and after a stated interval as suddenly revealed: the appearance of this light is entirely different from that of any revolving light. 5. The exhibition of a double light, which admits of other distinctions; for the one light may be placed vertically above the other, or in the same horizontal plane; or one may be white and the other red. Sometimes three lights are necessary to indicate the entrances to harbours, &c.

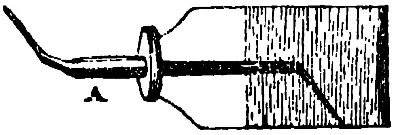
The average annual expense of maintaining a land light in Great Britain is about 500*l.*, and that of a floating light about 1200*l.*

DROPPING BOTTLE.

(*To the Editor.*)

Sir.—Having observed, during the progress of your valuable "Magazine of Science," &c., that your object has been to explain and simplify to the understanding of all, those subjects which are usually considered, partly from the expense attending their study, and partly from the great difficulties in manipulation, beyond the reach of the majority, I have intruded upon your notice by sending you an account of a modification of the dropping bottle which is in ordinary use; and which I think every person, having manipulated in chemistry to a very slight extent, must have found very inconvenient. I think it is more useful just now, at the time when most chemists in analyses use smaller quantities than they formerly employed, as in the tube chemistry, where I have found it very useful. Of course you know the ordinary dropping bottle is made of a common bottle, fitted with a cork, through which an aperture is made to fit in a tube tapering at one extremity to a fine point, and bent at a certain angle from the thicker part of the tube; another hole is then cut in the side of the cork to allow air to enter the bottle to supply the place of the water which has escaped from the bottle; now, to ensure good action in this it is necessary that the aperture in the cork for the entrance of air, should always be quite free, but as soon as the bottle is inverted, if the hole in the cork be at all large, or the tube the least stopped up by a bubble of air surrounded by water, the water rushes out at the side hole in the cork, and of course runs over the table, or down the side of your filter, or anywhere but where you want it; now my modification quite does away with this inconvenience, it is thus:—

Get a bottle with rather a wide mouth, and instead of having one tube, provide two, one being rather longer than the other; then make two holes in the cork, (which should fit air-tight into the bottle,) let the holes be equally distant from the edge of the cork, and from one another; one tube should have a larger bore than the other, (the longest should have the smallest bore,) these two tubes are then fitted into the apertures in the cork, the longest tube being fixed so, that when the cork is placed in the bottle it may be within the bottle, and the shortest and thickest must be outside the bottle. Perhaps a sketch will simplify it.



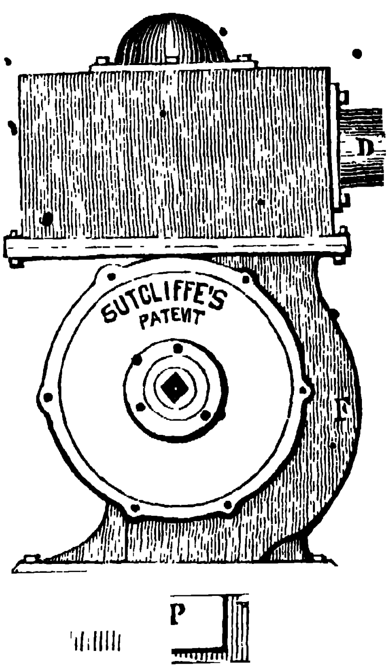
A is the shorter and thicker tube; B is the longer and thinner. It may either be filled by removing the cork in the ordinary way, or the best way is to immerse the bottle in water, and exhaust the air by the mouth at the orifice of the short tube, while the water rushes in at the other; when filled in this manner the cork may be varnished to the bottle with the sealing-wax varnish; when the bottle is inclined in use, the water first falls in drops, and then in a fine stream, which may be modified at pleasure, and thus not a drop is spilled. The quantity of water in the bottle ought to be no more than when it is inverted, and may rise or stand a little below the orifice of the longest tube.

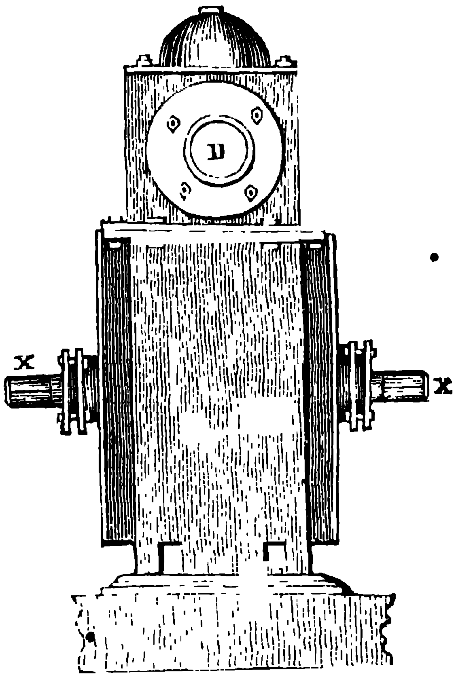
I must now apologize for having intruded so long upon your valuable time, remaining assured that any person trying the above will find it well worth the trouble, although comparatively a trifling point, still it is a very great convenience. A notice of this in your journal would, I am sure, be serviceable to a great number of your readers. J. W. G.

SIR R. PHILLIPS'S RULES FOR PRESERVING HEALTH.

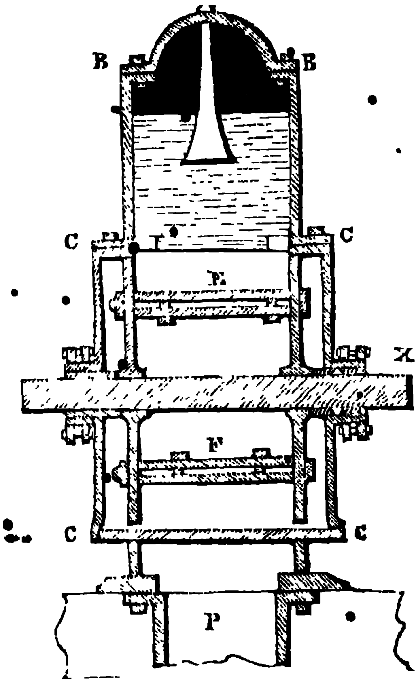
1. Rise early, and never sit up late. 2. Wash the whole body every morning with cold water, by means of a large sponge, and rub it dry with a rough towel, or scrub the whole body for ten or fifteen minutes with flesh brushes. 3. Drink water generally, and avoid excess of spirits, wine, and fermented liquors. 4. Keep the body open by the free use of the syringe, and remove superior obstructions by aperient pills. 5. Sleep in a room which has free access to the open air. 6. Keep the head cool by washing it when necessary with cold water, and abate feverish and inflammatory symptoms when they arise by persevering stillness. 7. Correct symptoms of plethora and indigestion by eating and drinking less per diem for a few days. 8. Never eat a hearty supper, especially of animal food; and drink wine, spirits, and beer, if these are necessary, only after dinner.

Fig. 1.





SUTCLIFFE'S PATENT ROTATORY PUMP.



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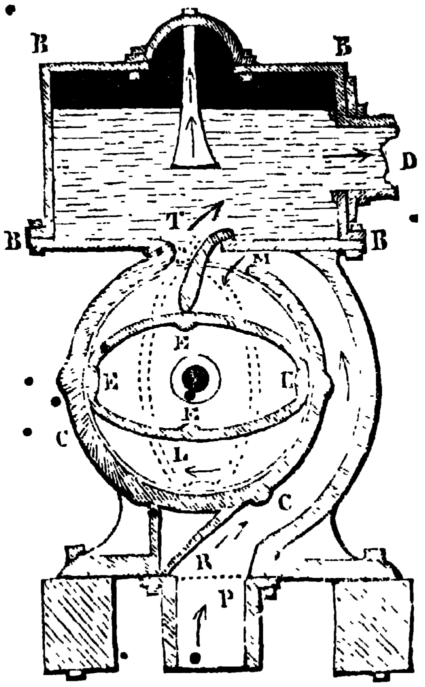

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SUTCLIFFE'S PATENT ROTATORY PUMP.

The following is a description of Sutcliffe's pump, with the result of an experiment on the discharging power of one now at work at the Limerick Docks, where it is found far superior to the chain and sucking pumps before in use. From the facility with which it can be applied in all those cases where pumps are required, and not being subject to get out of repair or choaked, it promises to be soon very generally used, not only in hydraulic works, but also in the navy, and those cases where the common pump was before used for household purposes. The patentee has been almost constantly connected with the execution of extensive works, as superintendant under Sir Thomas Deane and Company, and his attention was directed to the subject by the frequency of repairs required for the pumps usually employed in clearing out water from foundations and dams, their great friction, and the unequal flow of water from them; and we are informed that his invention has received the approval of Mr. Rhodes, the engineer, and Sir Thomas Deane and Company, the contractors for the Limerick Docks.

In this pump a vacuum is formed by the revolution of an elliptical frame within a cylinder, when the water rising, it is carried round in the lunar space between the ellipse and circle, shown on section, and discharged.

In the annexed figures, Fig. 1, is a side elevation, Fig. 2, an end elevation, Fig. 3, a vertical section along the length, and Fig. 4, a vertical section across the width of the pump, and the same letters refer to the same parts in each figure; X X, the axis by the rotation of which the elliptical frame E E E E, is carried round in the direction indicated by the arrow T, in Fig. 3; C C C C, the cylinder in which E E E E, moves both, having the common axis X X; F F, a jacket forming with the exterior of the cylinder a passage for the rising water from the pipe P; T, and T, Fig. 3, two extreme positions of a tongue which hinders the water brought round in the lunes from M, of escaping again at the same place, and which keeps touching the surface of the ellipse in its revolution; B B B B, a box into which the water is received and discharged through the discharging pipe D, and when D is closed, forces the water by the reaction of the air above through the forcing pipe P. When the pump is to be used, water is thrown in from above, which renders the contact between the elliptical valve or frame, and the cylinder water tight; after a few revolutions the air is exhausted, and the water rising is carried into B B B B, and discharged by D or P as before described. It is evident the discharge will depend conjointly on the velocity and sectional area of the water passing from the jacket into the lunes, and the area of the lunes and the velocity with which they are formed, or carried round. When the velocity and sectional area at M is sufficient to fill a lune in the time of half a revolution, a maximum effect is produced, and the discharge is found when the velocity at M is sufficient to fill the lunes, by multiplying the velocity of the lunes by twice their area of one. The foregoing figures are drawn from a pump of this construction now at work, and are laid down on a scale of 5-8ths of an inch to the foot, but the handles and fly are not shown. Four men discharge 128 gallons through a mean lift of 8 feet 6 inches in 30 seconds, two men working at each handle, and the fly being about 4 feet 6 inches in diameter. It should not be forgot that the facility this construction of pump affords for the application of a fly wheel, affords one though not the first of its recommendations. The water issues in one regular and continued stream from the discharging pipe; chips and clay attached to them when passed into the pump, getting through without injuring the motion or apparently taking from the discharge.

SULPHUR.

This is a very remarkable elementary form of matter, and its chemical examination will afford curious and useful information.

Sulphur, or *brimstone*, as it is vulgarly called, is a most abundant and well-known substance, occurring in commerce in three states, viz., *native sulphur*, *roll sulphur*, and *flowers of sulphur*. *Native sulphur*, so called from its occurring in a free or uncombined state, is found in large quantities in many parts of the world, and is singularly plentiful in Sicily, from whence the English market is almost exclusively supplied; it comes over in large square or oblong blocks, into which forms it has been cast after undergoing a rough purification by fusion, and the quantity thus annually imported is between 16,000 and 17,000 tons.

It is the purest commercial variety of sulphur, and is therefore largely consumed in the manufacture of gunpowder, of sulphuric acid, and in some operations of bleaching. Besides being found in the native state, sulphur occurs in combination with many metals, forming a class of compounds, called *sulphurets;* those of iron and of copper are well known to almost every one, under the common names of iron and copper pyrites.

Copper pyrites, or sulphuret of copper, is a most important ore of copper; and in the mining districts of Cornwall, during the operations of reducing the metal from its ore, vast quantities of sulphur are collected in an impure state; it is purified by being melted in pots, when part of the impurities rise to the surface, and are skimmed off, a small part settles to the bottom, and the purer portions are poured into cylindrical moulds of beechwood previously soaked in water to prevent the sulphur from sticking to them: in these moulds it concretes, and when they are opened, it appears in the state of *roll sulphur*, *stick sulphur*, or *roll brimstone*, which is too well known to require any further description.

The chief, and indeed the almost exclusive use of roll sulphur, is for tipping common matches, and its consumption in this apparently trifling article of manufacture is something quite enormous: it has been calculated that not less than three tons of sulphur are thus annually consumed in London alone. Sulphur matches are usually sold at the rate of seven-pence per thousand, and the value of a year's consumption of them in England amounted to somewhere about £26,000 sterling, previously to the introduction of lucifers.

Flowers of sulphur, or *flowers of brimstone*, is obtained by heating sulphur until it rises in vapour or sublimes into very large receivers, where it cools or condenses very rapidly into the form of a bright yellow crystalline powder. It is largely used in pharmacy, but is unfit for the manufacture of gunpowder or fireworks, in consequence of containing a little acid, which is formed during the sublimation, and this acid is highly injurious to the other materials employed in the art of pyrotechny. There is no difficulty in understanding why the terms *roll sulphur* and *stick sulphur* are applied to the second variety of sulphur; for it must be sufficiently evident, that the form of the substance resembles that of a roll or cylindrical stick, but perhaps the reason of the terms *flowers of sulphur*, or *flowers of brimstone*, is not quite so obvious, and therefore calls for an explanation, which is as follows :—

Sublimation, or the conversion of a solid substance into vapor by heat, and the reconversion of the vapor into the solid state by cold, is a process which was invented by the earliest alchymists, and they conferred the name of *flowers* upon all such sublimed products as were light and flocculent, under the idea (a fanciful one) that they bore some analogy to the natural flowers of plants,—hence they named the light and flocculent form of sublimed sulphur, *flowers of sulphur*; but this term at present is very commonly corrupted into *flour of sulphur*, perhaps on account of its state of division resembling that of flour. The vulgar term *brimstone* is a corruption of the Saxon word *brenstone*, which signifies burning-stone; a name applied to sulphur in consequence of its inflammable nature.

Having thus said a few words respecting the common varieties of sulphur, we will proceed to examine some of its properties. It is a solid substance of a pale yellow color, considerably heavier than water, its specific gravity varying between 1·970 and 2·080; it is very brittle, admitting of reduction to powder with the greatest facility. A curious circumstance happens, when this is done in a perfectly clean and dry Wedgwood's mortar, viz., the adhesion of the finely-powdered sulphur to its interior, so that it will not fall out if the mortar be turned upside down, which can easily be tried by powdering a bit of sulphur about the size of a hazel-nut very finely. This adhesion is owing to the excitation of electricity; the sulphur by the friction becomes *negatively* electrical, and therefore is strongly attracted to the interior surface of the mortar, which is *positively* electrical, in obedience to that law of the science of electricity, which teaches us that when bodies are in *opposite* electrical states they *attract* each other. The fact of sulphur becoming electrical by friction may be proved in another way, by simply rubbing a stick of roll sulphur pretty briskly on a warm and dry flannel, and then presenting it to some little fragments of cut paper, paper ashes, or gold leaf, any of which light substances will be strongly attracted by it.

Sulphur is perfectly insoluble in water; if a lump of it is put into water, and left for a day or two, it will be found that it has not diminished in weight nor in bulk; as it is thus insoluble in water, it is also tasteless. Sulphur melts with great facility upon the application of a very moderate heat: put a little bit at the bottom of a small glass tube, about half an inch in diameter, and four inches long, closed hermetically at one end, and heat it gently by the flame of a spirit-lamp; on the first application of the heat the sulphur crackles and splits (on account of the unequal expansion of its particles by heat); it then begins to melt, and soon becomes perfectly liquid, and of a bright yellowish-brown color; but now continue the heat, and you will find (contrary to what you might expect), that, instead of remaining liquid, it will soon become thick and pasty, so that at length the tube may be inverted without any chance of the sulphur running out; it will, however, regain its fluidity as it cools. This is a very curious property of sulphur, and remains as yet unexplained.

If, when in the pasty state, the heat is increased, the sulphur will also regain its fluidity, and begin to boil rapidly, emitting a dark orange-colored vapor, which sublimes and condenses in the upper and colder part of the tube. The temperature at which sulphur first enters into fusion is about 216° of Fahrenheit's scale; this is only 4° above the boiling point of water: it assumes the brown pasty state between 300° and 400°; it boils and sublimes at 600°, and if pure leaves no residue.

In passing from the fluid to the solid state, sulphur always manifests a tendency to assume the crystalline form; this will be seen upon examining the central part of a stick of roll sulphur, but very beautiful crystals can be easily obtained by observing the following directions :—Take an earthen basin capable of holding about a pint, place it in a large iron ladle containing sand enough to surround the basin up to its brim, set the ladle over a slow fire, and let it heat gradually; then having broken two or three pounds of roll sulphur into bits as large as hazel-nuts, drop them, a few at a time, into the basin, and as they melt, add more, and so on by degrees, until the basin is quite full of melted sulphur; then put on a thick worsted glove, and lift the basin out of the sand, and set it on the floor or upon a steady table, in order that it may cool gradually. Watch it as it cools, and there will be seen small crystals beginning to form at its sides, which will presently shoot over the surface, and as soon as the whole surface is covered with them, lay hold of the basin with a gloved hand, and quickly invert it, so that the interior portion of sulphur, which is yet fluid, may run out into an earthen pan placed to receive it; hold the basin thus inverted for about half a minute, and then, upon examining its interior, it will be found completely lined with beautiful needle-shaped crystals of sulphur.

This is an example of crystallization being effected by the fusion and slow cooling of a solid substance, and the larger the quantity of sulphur employed, and the slower it is allowed to cool, the larger and the more perfect will the crystals be; be careful not to employ too much heat, or otherwise the sulphur will become pasty and intractable: no more heat is requisite than just enough to melt it. Sulphur is highly inflammable: it takes fire at the temperature of 300° when heated in the open air, and burns with a peculiar pale blue light, emitting, at the same time, a most suffocating odour, commonly called a "sulphury smell." The tip of a common match, when applied to red-hot tinder, in the operation of "striking a light," furnishes at once a specimen of the flame of sulphur, and the odour of its combustion.

DESTROYING MICE, &c. IN THEIR LURKING PLACES.

M. **Thenard** has submitted to the Academy of Sciences a plan for destroying noxious animals, when they have taken refuge in their hiding places. The instrument for destruction is sulphuretted hydrogen, which he had remarked to be peculiarly deleterious to animal life. Animals, when allowed to breathe the pure gas, fall down as if struck with a bullet. Even when considerably diluted with atmospheric air, the effects are deadly. A horse dies in less than a minute, in air containing $\frac{1}{250}$ of this gas. A dog of moderate size is speedily killed in air containing $\frac{1}{1000}$, while a greenfinch expires in a few seconds in air possessing $\frac{1}{1500}$ of sulphuretted hydrogen. Influenced by these facts, the French chemist proposed the employment of this gas to several individuals for the purpose of extirpating noxious vermin, but his suggestions being treated with indifference, he determined to put the method in practice by his own experiments.

His first trial was in an apartment infested by rats, which showed themselves occasionally during the day, and at night were actively engaged in plundering a chest of oats, to which they had access through an aperture of their own formation. The holes by which they retreated amounting to 18 in number, Thenard adapted to each of them in succession, retorts capable of containing half a pint measure, by introducing the beak of the retort and filling up the interval round its neck with plaster. Sulphuret of iron was deposited in the retort, formed from a mixture of iron filings, sulphur, and water, and dilute sulphuric acid was introduced by means of a tube placed in the tubulure. The sulphuretted hydrogen was disengaged with great rapidity, and in a few minutes not a rat remained alive in the building. His next experiment was in an old abbey, where he was equally successful, and having opened up part of the wall he found many dead rats. He recommends the application of this method to the destruction of moles, foxes, and all animals which cannot be extirpated by the usual means. Thenard then gives popular directions for the formation of the materials required to produce the gas.

Mix 4 parts of iron filings, and 3 parts flowers of sulphur in a mortar with a pestle. Place the mixture in a convenient vessel, and moisten it with 4 parts of boiling water, stirring it with a piece of wood or glass. Add gradually afterwards 4 parts more of water, and introduce it into the retort. Pour upon the mixture common oil of vitriol diluted with five times its volume of water, and continue to add it gradually till the effervescence ceases. Should any of the gas escape into the apartment and occasion inconvenience it may be removed by dropping a little sulphuric acid upon bleaching powder. The holes should be closed immediately, to prevent the disagreeable effects of the putrefaction of the carcases of the animals which have thus been destroyed.

METALS USED FOR ANCIENT COINS.

The metals used for ancient coins and medals are well known to be principally three; gold, silver, and the various modifications of copper.

It is looked upon as an undeniable axiom among collectors, that the more ancient the gold employed in coinage is, the greater is its purity. The standard of the utmost purity of gold is well known to be twenty-four carats. From these twenty-four carats almost every nation in modern Europe has deducted nearly two, which are made up of alloy; so that the most usual purity of coined gold amounts to about twenty-two carats.

Now the gold of the coinage of Philip of Macedon, Alexander the Great, Demetrius, and other princes, and cities, within a few centuries of their respective ages, is of superior purity, and very little inferior to fine gold. Indeed, the only reason which appears, in these early times, to have occasioned the use of alloy at all, seems to have been, that, without it entirely, the gold could not have been worked. For the fact is, that little more alloy is allowed than was absolutely necessary for the purposes of fabrication.

The Roman gold coinage, down to Vespasian, is very good, though not so pure, for there is only a forty-eighth part of the fine gold alloy. After that prince, indeed, the alloy is doubled, so that it rises to a twenty-fourth.

The silver of the ancient Greek medals is of corresponsive chastity, only admitting, as the gold, a very minute proportion of alloy; in like manner as the general run of modern coinage has likewise observed the same proportion of alloy in the gold and the silver coin. But the Roman silver coinage, even in its greatest antiquity and purity, by no means equals the Greek; for as the state paid all their debts in silver, its debasement was a great advantage. However, it can never be called base money till the reign of Didius Julianus, who, squandering great wealth in his infamous purchase of the empire and subsequent donations to the prætorians, to induce them to maintain that purchase, found himself forced to have recourse to a vast degradation of the silver coinage. After this period, a pound of such silver is only worth a third part of the value of real silver.

Proceeding to the brass employed in mintage by the ancients; when pure, which is very uncommon, it consists of two kinds; the red, or what the ancients called Cyprian brass, what we call copper; and the yellow. The first of these is very uncommon in the largest size of brass medals, or what are called large brass; but is common in the other sizes. Taking the mixtures according to their dignity, the first which occurs is *electrum*, being a mixture of equal parts of gold and silver. The coins of the kings of the Cimmerian Bosphorus, during the imperial ages of Rome, are struck in this metal, and are very scarce.

The next in value was Corinthian brass; had the ancients even struck a single medal in that metal, which, unfortunately for many a fond antiquary, they did not. That celebrated metal, during the very little time it was ever known at all, was certainly only employed in the fabrication of vases and other ornamental toys. Indeed its æra of being in use was, at any rate, very short; for Pliny the elder tells us, that for a long time it had been utterly unknown. With reason, therefore, we may laugh at those deluded authors, who pretend not only to find this metal in imperial coins, but even to find three kinds of it; namely, 1st That in which gold predominates; 2nd. That in which silver is most eminent; 3rd. That in which brass is the most plenteous metal. We suspect Enea Vico, one of the earliest writers on medals, to have been the author of this strange idea; which Savot, a writer of the beginning of the seventeenth century, had sense enough to confute. The mistake must have arisen from the circumstance of the first propagator of it not being able to account for the various mixtures and modifications of brass, observable in ancient coins of the large size; and which, especially in so common a metal, appear so odd to modern eyes. But, not to mention the authority of Pliny, above quoted, which is perfect proof; or that of later antiquaries, who all declare that they have never seen one coin of Corinthian brass, or brass mingled with the slightest proportion of gold or silver; there is another evidence of such simple structure, and yet such vast weight, that nothing can well mark the absence of the antiquaries more than its omission, namely, that it is in the imperial *ases*, worth about a penny, that this precious metal is discovered. As the great size and weight of these *ases* are well known, and they passed in common currency for about a penny only, it were truly surprising could the ancients have afforded any gold or silver in their fabric; nay, a predominance of either metal over the brass.

The fact is, that those coins, which some antiquaries denominate of Corinthian brass, are only struck on a mixture of the red and yellow brass mentioned above. To place the succeeding sorts of mixtures according to their actual value, were an attempt as superfluous as difficult.

Many of the Roman coins are of what the French call *potin*, which is described as a mixture of copper, lead, and tin, with a fifth part silver. The Abbé Rothelin, a noted collector of this century, had a complete suite of this metal. The suite must of consequence have been the work of the Egyptians, who used that metal, or of Roman forgers, through the several reigns, in imitation of the silver currency. As must likewise that sort called by the Italians *metalline*, which are common in the third and fourth ages of Roman emperors, and are only of copper tinged or washed with silver. Many coins of what is called large brass are of those mixtures now called pot-metal and bell-metal. There are medals of Nero of a most debased and brittle brass. After the days of Gallienus coinage of brass with a very minute addition of silver may, be in many instances regarded as that authorised by the state. As may those of copper or iron plated with silver, which always, however, console the collector, for their diminution of intrinsic value, by their indubitable antiquity.

Coins have been found in lead of undoubted antiquity: of the Greek those of Tigranes in particular. In Rome they must have been pretty ancient, for, Plautus mentions them in one or two passages of his plays; and a few imperial ones have been found. That strange work the *Notitia Imperii Romani*, written in the days of Arcadius and Honorius, and worthy of that benighted period, mentions, coins of leather, among others, of which delineations are there given; and which are totally unlike any ancient coins yet found or ever to be found. It may not be improper to add a hint as to the number of ancient coins, with quite different reverses, which we have. The Abbeé Rothelin had in his cabinet no less than 1800 coins of Probus, whose reign was but of seven years. The number of Roman gold imperial coins may amount to 3000; the silver to 6000; and the brass to 30,000. The whole of the different ancient coins, known to us, to about 50,000.

SHOOTING STARS.

The origin and nature of these well-known meteors are involved in great obscurity, and have, of late years, excited extraordinary interest by their periodical appearances in unusually great numbers.

Phenomena of Shooting Stars.—The apparent magnitudes of these meteors are widely different. The greater part of them resemble stars of the 3d, 4th, 5th, and 6th magnitudes; but some occur which surpass stars of the 1st magnitude, and even exceed Jupiter and Venus in brilliancy. In some of them the globular form can be easily recognized: these are, in every respect, similar to *fire-balls;* and, in fact, it is impossible, from their appearances, to make any distinction between the larger shooting stars and the smaller individuals of meteors to which the name of fire-balls is usually appropriated.

Shooting stars appear to be equally numerous in every climate. The weather seems to have no influence upon their number. They are observed at all times of the year; but, generally speaking, they appear to be more abundant in the end of summer and autumn than at the other seasons.

Some of the shooting stars leave a luminous train behind them, which marks their path through the sky with a milk-white light. These trains for the most part disappear in a few seconds; but sometimes they continue longer, and even for several minutes. In the case of actual fire-balls, Dr. Olbers observed trains which continued from six to seven minutes; and Brandes, in one instance, estimated that fifteen minutes elapsed between the extinction of the fire-ball and the disappearance of the luminous train. The trains in general assume the form of a cylinder, the interior of which is void of luminous matter; and not unfrequently, before their disappearance, they take a curved form. The most probable explanation is, that they are caused by a gaseous matter left behind by the meteor, and bent by currents of air.

The older philosophers had formed various theories to explain these remarkable phenomena. By some they were supposed to be the products of an oily sulphurous vapor existing in the atmosphere, which being disposed in thin layers, and becoming inflamed by some means, would exhibit the appearance of a clear brilliant spark passing rapidly from one point to another. About the middle of the last century, when the effects and phenomena of electricity began to be better understood, Beccaria and Vassali, among others, regarded the shooting stars as merely electrical sparks; an hypothesis which was soon shown to be untenable. At a later period, when the inflammable nature of the gases became known, Lavoisier, Volta, Herbert, Toaldo, Gren, and others, referred these meteors to hydrogen gas, which, by reason of its inferior density, they supposed must be accumulated in the higher regions of the atmosphere. Dalton, however, showed that such accumulation cannot take place, inasmuch as all the gases which constitute the atmosphere must be equally diffused through its whole extent, according to the law of Mariotte. Deluc maintained that certain phosphoric exhalations generated in the earth, and becoming inflamed in the sky, formed the true essence of the shooting stars.

In this state the subject remained when Chladni published his celebrated work, on the causes of the masses of iron and other similar substances found in Siberia by Pallas, in which he clearly established, by comparing the circumstances of a great multitude of observations, that the fire-balls are meteors having their origin beyond our atmosphere; that, in fact, they are masses of nebulous matter moving in space with planetary velocities, which, when they come in the way of the earth in its revolution about the sun, and enter the atmosphere, are inflamed by its resistance and friction, and become luminous, sometimes scattering masses of stone and iron on the ground. Halley, Wallis, Pringle, Maskelyne, and others, had previously assigned a cosmical origin to these meteors, but without suspecting that masses of stone and iron fell from them. The close resemblance which the greater part of the shooting stars present to fire-balls, at once induced Chladni to consider these phenomena also as cosmical; that is to say, as small masses of matter not having their origin in our atmosphere, but entering it from without, and which are either entirely consumed in it, or become extinguished when they have passed beyond it.

These conclusions, however, required to be confirmed by a more accurate investigation of the phenomena; for as yet no exact determination had been made of the actual average heights of the shooting stars above the earth, or of their orbits, velocities, or magnitudes. In the year 1798, this important but difficult inquiry was undertaken by Professors Brandes of Leipsig, and Benzenberg of Düsseldorf (both at that time students in Göttingen). Having selected a base line, about 9 miles in length, they placed themselves at its extremities on appointed nights, and observed all the shooting stars which appeared tracing their courses through the heavens on a celestial map, and noting the instants of their appearances and extinctions by chronometers previously compared. The differences of the paths traced on the maps afforded data for the determination of the parallaxes, and consequently the heights and the lengths of the orbits. On six evenings, between September and November, the whole number of shooting stars seen by both observers was 402; of these 22 were identified as having been observed by each in such a manner that the altitude of the meteor above the ground at the instant of extinction could be computed. The least of the altitudes was about 6 English miles. Of the whole there were 7 under 15 miles; 9 between 45 and 90; 6 above 90; and the highest was above 140 miles. There were only 2 observed so completely as to afford data for determining the velocity. The first gave 25 miles, and the second from 17 to 21 miles in a second. The most remarkable result was, that one of them certainly was observed not to *fall*, but to move in a direction away from the earth.

By these observations a precise idea was first obtained of the altitudes, distances, and velocities of these singular meteors. A similar but more extended plan of observation was organized by Brandes in 1823, and carried into effect at Breslau and the neighbouring towns by a considerable number of persons, observing at the same time on concerted nights. Between April and October about 1800 shooting stars were noted at the different places; out of which number 62 were found which had been observed simultaneously at more than one station, in such a manner that their respective altitudes could be determined, and 36 others of which the observations furnished data for estimating the entire orbits. Of these 98, the heights (at the time of extinction) of 4 were computed to be under 15 English miles; of 15 between 15 and 30 miles; of 22 between 30 and 45; of 33 between 45 and 70; of 13 between 70 and 90; and of 11 above 90 miles. Of these last 2 had an altitude of about 140 miles, 1 of 220 miles, 1 of 280, and there was one of which the height was estimated to exceed 460 miles.

Of the 36 computed orbits, in 26 instances the motion was downwards, in one case horizontal, and in the remaining 9 more or less upwards. The velocities were between 18 and 36 miles in a second. The trajectories were frequently not straight lines, but incurvated sometimes in the horizontal and sometimes in the vertical direction, and sometimes they were of a serpentine form. The predominating direction of the motion of the meteors from north-east to south-west, contrary to that of the earth in its orbit, was very remarkable, and is important in reference to their physical theory.

A similar set of observations was made in Belgium in 1824, under the direction of M. Quetelet, the results of which are published in the *Annuaire de Bruxelles* for 1837. M. Quetelet was chiefly solicitous to determine the velocity of the meteors. He obtained six corresponding observations from which this element could be deduced, and the results varied from 10 to 25 English miles in second. The mean of the six results gave a velocity of nearly seventeen miles per second, a little less than that of the earth in its orbit.

Another set of corresponding observations was made in Switzerland on the 10th of August, 1838; a circumstantial account of which is given by M. Wartmann in *Quetelet's Correspondance Mathématique* for July, 1839. M. Wartmann and five other observers, provided with celestial charts, stationed themselves at the observatory of Geneva, and the corresponding observations were made at Planchettes, a village about 60 miles to the north-east of that city. In the space of seven and a half hours, the number of meteors observed by the six observers at Geneva, was 381; and during five and a half hours, the number observed at Planchettes by two observers, was 104. All the circumstances of the phenomena—the place of the apparition and disappearance of each meteor, the time it continued visible, its brightness relatively to the fixed stars, whether accompanied with a train, &c.—were carefully noted, and the trajectories projected on a large planisphere. The extent of the trajectories described by the meteors was very different, varying from 8° to 70° of angular space. The velocities appeared also to differ considerably; but the average velocity was supposed by M. Wartmann to be 25° per second. It was found, from the comparison of the simultaneous observations, that the average height above the ground was about 550 miles; and hence the relative velocity was computed to be about 240 miles in a second. But as the greater number moved in a direction opposite to that of the earth in its orbit, the relative velocity must be diminished by the earth's velocity (about 19 miles in a second). This still leaves upwards of 220 miles per second for the absolute velocity of the meteor, which is more than eleven times the orbital velocity of the earth, seven and a half times that of the planet Mercury, and probably greater than that of the comets at their perihelia.

Such are the principal facts which have yet been established respecting the heights, velocities, and orbits of the shooting stars; and it is from these chiefly that we are enabled to form any probable conjectures respecting their origin. And since it is now established that no difference is observable between the larger shooting stars and small fire-balls, both having similar altitudes and velocities, and presenting absolutely the same appearances, we may assume them to be of the same nature, and that whatever has been proved respecting fire-balls will apply equally to the larger shooting stars.—Whether the meteoric appearances to which the latter term is applied may not include objects of totally different natures, is a question admitting of doubt. It is possible that among the shooting stars there may be objects which are merely electric sparks, or which have their origin in spontaneously inflammable gases, known or unknown, existing in the atmosphere; but the greater part of them must be considered as identical with fire-balls.

(*To be continued.*)

VEGETABLE TOOTH BRUSHES.

TAKE marine marsh-mallow roots, cut them into lengths of five or six inches, and of the thickness of a middling rattan cane. Dry them in the shade, but not so as to make them shrivel.

Next finely pulverize two ounces of good dragon's blood, put it into a flat-bottomed glazed pan, with four ounces of highly-rectified spirit, and half an ounce of fresh conserve of roses. Set it over a gentle charcoal fire, and stir it until the dragon's blood is dissolved; then put in about thirty of the marsh-mallow sticks; stir them about, and carefully turn them, that all parts may absorb the dye alike. Continue this until the bottom of the pan be quite dry, and shake and stir it over the fire, until the sticks are perfectly dry and hard.

Both ends of each root or stick should, previous to immersion in the pan, be bruised gently by a hammer, for half an inch downwards, so as to open its fibres, and thereby form a brush.

They are generally used by dipping one of the ends in the powder or opiate, and then, by rubbing them against the teeth, which they cleanse and whiten admirably.

Other Vegetable Tooth Brushes.—There are several cheap sorts of these tooth brushes, which are made in the same manner as the genuine ones, except that, as a basis, rattan cane, or even common deal, cut round, is used instead of the marsh-mallow roots.

SENSES OF FISHES.

FISHES, like other red blooded animals, have most of them two eyes. We say most, because, while anatomy has failed to detect them at all in a few species, of which the gastrobranchus is an instance, the four-eyed anableps, or loach, exhibits the wonderful anomaly of four apparent eyes, looking through two orbits. Altogether the visual organs of fishes exhibit diversities of situation, form, and external appearance, more numerous and striking than those of most other animals. The general situation of the eyes in fishes is that of one on each side of the head: in what are termed flat fish, they are however both placed on the same side, with a slightly oblique aspect. As the habits of these fish force them to recline on one side on the ground, without this peculiar formation, the sight of one eye would have been lost; but with the eyes thus placed, the fish can direct both of them upwards, as well to protect itself, as to watch for its prey which swims over it.

The organs of hearing in fishes have been the objects of much discussion, their existence in them having been denied by naturalists, until anatomy at length removed all doubt on this point, although some anglers are still sceptical on the subject. It is remarkable that even the observant Linnæus was not able to satisfy himself that any auditory organs could be discovered in fishes, an oversight which probably arose from the particular specimens he examined, as in some fishes no external orifice can be detected. But even when such is the case, there is always an internal auditory apparatus, and the sonorous wave reaches a tremulous mass veiled under a thin body lamella, and from thence the tremors are spread over the *sensitive* organ within. It was formerly supposed that the oscillations gave a tremulous impulse to the water around, and that their impressions were imparted to the *surface of the body;* whose irritability was thereby excited. But had this been the case, all impressions received must have been general; they could have had no local direction, which was evidently contrary to observed facts, and to the phenomena of hearing altogether. The Abbé Nollet ascertained, by conclusive experiments, detailed in the *Histoire de l'Academie Royale des Sciences*, 1743, p. 26, that the human ear was susceptible to sound when immersed in water. The attention of Camper, Hunter, Vic d'Azyr, and Monro, was afterwards directed to the demonstration of the auditive apparatus in these animals.

The auditive organ, however, is unquestionably much more simple in fishes than in animals of a superior grade; and there is, as regards this organ, a regular gradation from the first of these to fishes. It varies in different orders of them; but in all it does exist, and consists of three curved tubes, which unite with one another: this union forms in some only one canal, as in the cod, salmon, ling; and in others a pretty large cavity, as in the ray kind. In the jack or pike there is an oblong bag, or blind process, which is an addition to these canals, and communicates with them at their union.

As fishes thus evidently possess the organ of hearing, the faculty itself can be no longer doubtful; and indeed numerous facts have been brought forward in confirmation of its existence. Mr. Hunter caused a gun to be fired out of sight of a fish-pond: the report affected the fish uniformly, so that they all vanished to the bottom, and were many minutes before they again made their appearance. Gold and silver fish have been frightened to death by the report of a pistol; and any sudden noise, if considerable, will often make them start violently. In Germany it is common to summon the fishes by a bell to be fed. In China, a kind of drum, called a *tamtam*, is also employed to drive fishes into a net; nor any other confirmatory facts wanting.

The organs of taste in fishes are very obscure, though there is little reason to doubt that they have some discriminating powers in the choice of their food beyond that of smell, which we know to be very acute. The tongue is, however, very imperfectly developed; it presents no papillæ, and is supplied with none of the usual gustatory nerves. Fishes have also been known to swallow the plummet of the fisherman instead of the bait; and hence it is probable that this sense is at least indistinct and weak. In this, however, as in every other part of our present subject, great diversity prevails. Cod, for example, will swallow almost any thing, such is their voracity and insensibility: but on the other hand, it must be confessed, that some fishes are sufficiently dainty, and must be tempted by baits dressed up with epicurean nicety; and were we to follow up the instructions of the ancients, we should add essential oils to make the morsel more piquant. It is however probable, after all, that this gastronomic preference is determined rather by the acuteness of the smell than by the taste; and in this view it may indeed be possible, that the effluvia from some vegetable oils may so resemble the odours emitted by some insects, as to mislead the fishes.

The organs of smell in these animals are both external and internal, and present an endless variety in form and structure in the different species. In some the nostrils are single, and in others divided: they are round in the codfish, oval in the conger eel, and oblong in others. They are placed in some cases midway between the snout and eyes; in others they approximate the eyes; and in others again they are nearer to the snout. By means of muscular fibres they can contract or dilate their orifices. The internal olfactory organs consist, as in the *Mammalia*, of osseous cavities, supporting a mucous membrane called pituitary, which is of exquisite sensibility, and open to the emanations given off from bodies. The olfactory nerves have their origin in swellings or tubercles, almost as large as the brain itself. In the cartilaginous tribes these nerves are very soft; in the spinous they are long and slender: and in fact, following the analogies of the other organs of sense, their peculiarities of structure are endless. Finally, they are ramified throughout the pituitary membrane.

The sense of smell in fishes is supposed by some to be very acute; but although Dr. Fleming considers the organs themselves as furnishing a useful guide to a systematic distribution of the species, yet he does not think the sense of smell so well defined as might be wished. This is a subject which greatly concerns the angler; and we will ourselves observe on it, that the well known voraciousness of fishes, and the eagerness with which they will seize a metal button, or any glittering object, all seem to point out the organ of sight as the principal instrument by which they discover their food, and consequently that the angler's aim should be directed to that point. The acuteness or dulness in the sense of smelling among fishes is therefore to a certain degree undetermined. The fishers of early times indeed attributed to them a love of every savoury substance, and of many fetid matters; while, as we have already remarked, essential oils were deemed irresistible lures to them. And these opinions are so prevalent in all treatises on ichthyology, and apparently so founded on fact, that we cannot but yield some credence to the assertions respecting the acuteness of these alleged olfactory perceptions, which indeed the presence and marked development of the organ might of themselves lead us to expect.

The organs of touch in fishes are not strongly marked. The skin is destitute of the papillary membrane; and this circumstance has engendered in the minds of anatomists a belief, that the sense of touch is altogether wanting, or at best but very obscure. The well known fact, however, that both jack and trout, particularly the latter, enjoy the titillation of the hand, and even lean thereon for more close contact (in which propensity has originated the poacher's habit of taking the largest trout by *tickling*, as it is termed), is a sufficient proof that the sense does exist, and that in some fishes it is active. In irritability also they are not defective, as appears from the resistance they make to violence, but nevertheless we do not believe their feelings to be acute.

Fishes have no organs of voice. This defect must be apparent, when we consider that they have neither larynx nor lungs properly so called. The small sound emitted by them occasionally is a kind of sigh, produced by expelling the air through the nearly closed gill-flap. The dying snap of the herring is caused by a convulsive closing of the same part; and the sucking or chuck of the chub, in warm sunny days, when swimming near the surface, is, we are inclined to think, effected by the lips. This action may probably be occasioned by some application of the mouth to the large leaves of aquatic plants, for it is most observable when the fishes are beneath or near them.

SPECTACLES.

RULES FOR JUDGING WHEN THE EYES REQUIRE THE ASSISTANCE OF.

1. When we are obliged to remove small objects to a considerable distance from the eye in order to see them distinctly.

2. If we find it necessary to get more light than formerly, as, for instance, to place the candle between the eye and the object.

3. If, on looking at, and attentively considering a near object, it fatigues the eye and becomes confused, or if it appears to have a kind of dimness or mist before it.

4. When small printed letters are seen to run into each other, and hence, by looking steadfastly on them, appear double or treble.

5. If the eyes are so fatigued by a little exercise, that we are obliged to shut them from time to time, so as to relieve them by looking at different objects.

When all these circumstances concur, or any of them separately takes place, it will be necessary to seek assistance from glasses, which will ease the eyes, and in some degree check their tendency to become worse: whereas, if they be not assisted in time, the weakness will be considerably increased, and the eyes be impaired by the efforts they are compelled to exert.

MEMORANDA.

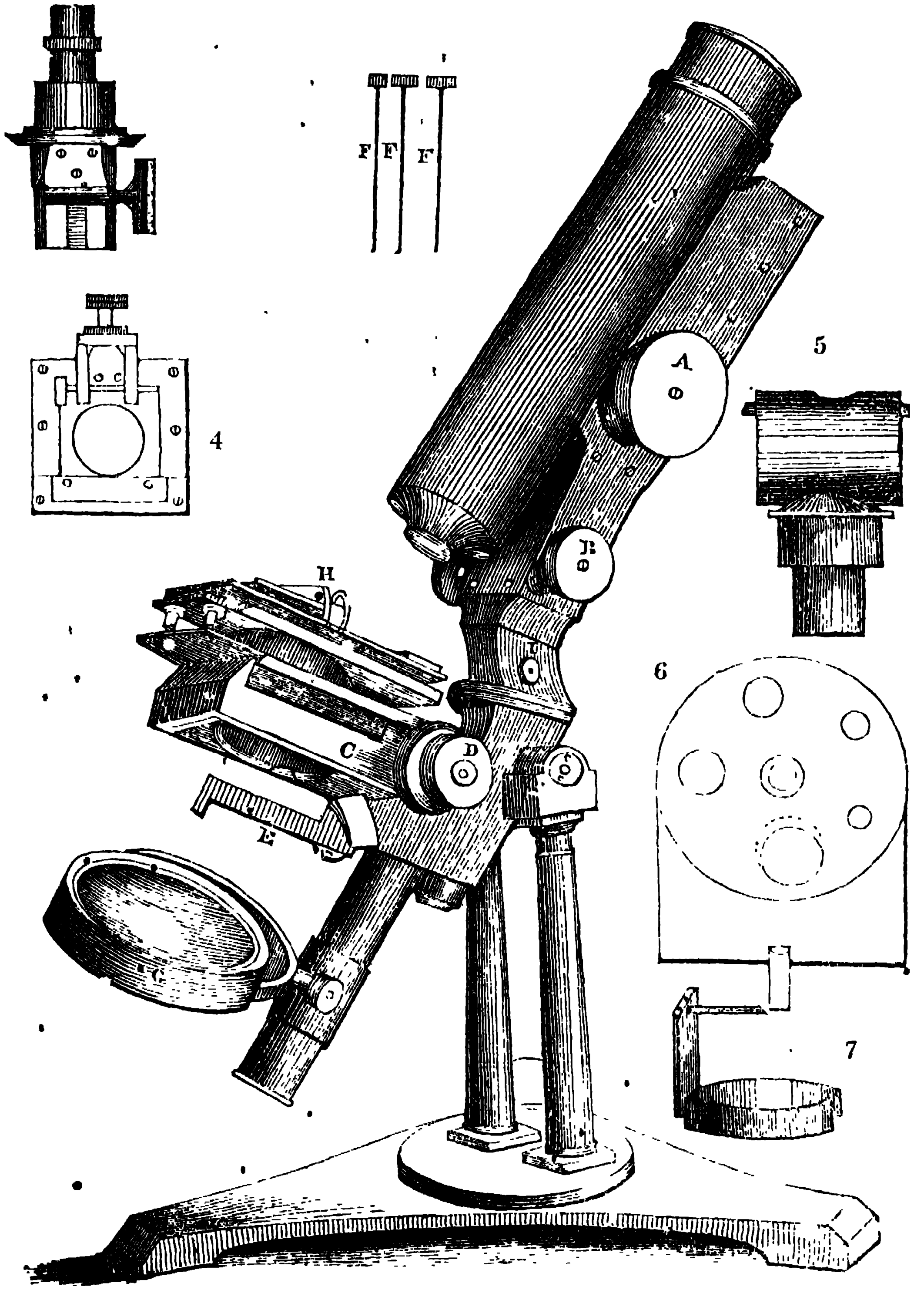
Pew's Composition for Covering Buildings.—The hardest and purest limestone (white marble is to be preferred), free from sand, clay, or other matter; calcine it in a reverberatory furnace, pulverize and pass it through a sieve. One part, by weight, is to be mixed with two parts of clay well baked and similarly pulverized, conducting the whole operation with great care. This forms the first powder. The second is to be made of one part of calcined and pulverized gypsum, to which is added two parts of clay, baked and pulverized. These two powders are to be combined, and intimately incorporated, so as to form a perfect mixture. When it is to be used, mix it with about a fourth part of its weight of water, added gradually, stirring the mass well the whole time, until it forms a thick paste, in which state it is to be spread like mortar upon the desired surface. It becomes in time as hard as stone, allows no moisture to penetrate, and is not cracked by heat. When well prepared it will last any length of time. When in its plastic or soft state, it may be colored of any desired tint.

Red Japan.—For this purpose the base of the japan ground must be made up with madder lake, ground up with oil of turpentine; this forms the first ground; when perfectly dry, a second coat must be applied, composed of lake and white copal varnish; and the last with a coat composed of a mixture of copal and turpentine varnish mixed up with lake.

Blue Japan.—The first coat must be given with artificial carbonate of barytes, ground with oil varnish; the second with Prussian blue, ground in copal varnish, and finished as before stated

Black Japan.—This is obtained by applying finely levigated ivory black, ground up with linseed oil varnish; the second coat must consist of the same pigment ground up in copal varnish.

Fig. 1.



POWELL AND LEALAND'S MICROSCOPE.

POWELL AND LEALAND'S MICROSCOPE.

The daily acknowledged advantages arising to every branch of natural science from the use of the microscope have induced us to present, after some years' experience, an instrument modified to the present improvements, and more within the reach of scientific observers, than that we have of late constructed. In the following description almost every portion of the instrument is alluded to, and figures of the different parts appended; and it has been our object to give every individual credit for his improvements, where at least we consider them of such importance as to be placed on record.

The points most deserving of attention are the following:—The double pillar, as first made by Mr. George Jackson, which possesses the advantage of being lighter, and distributes the weight more equally upon the foot. We have also introduced a circular motion to turn the body off the stage to examine the object, and to change the object-glass to prevent it from falling upon the object. The stage is made larger and stronger than in former microscopes of this size, and the pinion and screw are of the same diameter as in larger instruments. This description of stage was first constructed by Mr. Turrell. There are, however, two or three other improvements and modifications, such as the method for adjusting the object-glass to compensate for the thickness of the glass covering the object.

Fig. 1. *The Microscope in the position for general use.*—As the most convenient method of using the instrument is in this position, it will be necessary after taking it out of the case, to turn it by means of the pillars on its moveable foot, in order that the principal weight may be over one of the feet. When the person using it is standing, and the body of the microscope perpendicular, it is then firmest as taken from the case. A, the coarse adjustment for the body, which rests on two rollers, and is moved by a rack and pinion. B, the fine adjustment, which is a screw with a cone, against which there is a spring pressing against the cradle, which carries the compound body. C, milled head, which moves the stage to the right and left. D, heads that move the stage at right angles to the other (C)—there is one head on each side of the stage to this motion, in order that both hands may be employed at the same time, one on C, and the other on the opposite side, when a rotatory movement is required to search for animalcules, or other objects. When the two screws, C and D, are used together, a diagonal motion, and when separate, motions at right angles with each other are obtained. E arm for holding the stops, F F F, (fig. 2,) which are used when viewing opaque objects.—To place them for use, push down the mirror G to the extremity of the stem; put the stop into the spring-hole, turn it into the centre of the stage, and raise it as high as the slide on which the object is placed will admit of. G mirror for illuminating objects.—When the concave side is used it should be raised nearly to the stem, in order that the rays of light proceeding from it may reach the object before crossing, for by this means the most intense light is obtained. It is invariably used for opaque objects, together with the Lieberkuhn. At night it will be necessary to use the larger condensing lens, which should be placed at about its focal distance from the lamp, with its convex side to the mirror, and adjusted till the rays of light fill it. H, spring-piece for holding the slides on the stage.—The most convenient mode of placing them is, to push up the spring-piece sufficiently high to allow the slide to go on the stage, and then compress it until it holds it. Any number of slides of the same width may then, after it has been set, be put in without that trouble. Should the slides be very wide, in order to have the whole range of the stage, it will be necessary to observe if the centre of the slide corresponds with the line on the centre of the stage; if not, it must be altered until it does.

Fig. 3. *Achromatic Condenser.*—This is adapted under the stage. It will be observed there are two notches in the plate, capable of admitting the two springs on the condenser; put it in, and turn it till the milled head is in the best position for use; bring your object into focus, and adjust the condenser till you see distinctly the image of the lamp, or the frame of the window, if by daylight; and then you may be assured the most intense light is obtained, which is not always desirable. The light is lessened or diminished by turning back the condensing lens, by means of the milled head.

Fig. 4. *Micrometer for measuring objects.*—The upper part of the stage is taken out of the plate, put into the micrometer, and the whole put again on to the stage. To measure an object, observe that the micrometer stands at nought; then adjust one edge of the object till it comes in contact with the web in the eye-piece, by the milled head C; then adjust it across by the head of the micrometer D, when the number of revolutions and points may be taken.

Fig. 5. *Phial holder for viewing Chara, &c. while in a living state.*—It is adapted to go in the plate of the stage, and is put in after taking the upper part of the stage off.

Fig. 6. *Diaphram of French construction.*—Which is used in front of the lamp, to cut off extraneous light, and intercept the rays before they reach the mirror. It goes into the stem of the *large* condensing lens, which is easily drawn out, and the diaphram substituted. It should be placed at about eight inches from the mirror, and if an image of the aperture is obtained in the body, but a small portion of the field of view will be illuminated. The size will depend upon which aperture is used, and the relative distances of the mirror from the object, and the diaphram from the mirror; it is useful, when any very delicate structure is to be observed, as the darkness around the object renders the markings more distinct.

Adjusting Object-glasses.—These are made to adjust, in order that they may be as perfect for viewing objects covered with glass, as those that are not. As it is of material consequence that the object-glass should adjust to suit the various thicknesses of glass that are used, and as it is impossible to measure accurately the thickness, the best method to adjust the object-glass in this:—Place it at the point for viewing objects uncovered, which will be known by observing that the circular line under the word *uncovered* corresponds with the fixed line; or, the more ready way is, to adjust it down as far as it will allow, as we always make them to stop at the corrected point. Bring the object into focus by the adjustment of the body, then adjust the object-glass till the upper surface of the glass which covers the object is in focus; this can very readily be done while the person is observing, by taking between the finger and thumb the milling on the object-glass, and turning it to the left; then bring the object again into focus by the body, and the adjustment is perfect. For the principle of this important method of correcting object-glasses for looking through glass, we are indebted to Mr. Andrew Ross.

Fig. 7. *Steel Disc, by which Drawings are made.*—To use it, place the body of the microscope horizontally, take the cap off the eye-piece, push on the disk to the line marked upon the long eye-piece, and adjust it till the arm is horizontal.

The price of the instrument above described varies from forty to sixty guineas, depending upon the number of powers and apparatus attached thereto; a very complete microscope, however, of this kind may be obtained for about forty-five guineas.—*Microscopic Journal.*

SHOOTING STARS.

(Resumed from page 366, and concluded.)

Physical Theory of the Shooting Stars.—Some philosophers, as already stated, have ascribed an atmospheric origin both to the shooting stars and fire-balls; but the observations of Brandes, and more particularly those of Wartmann, which prove that many of them appear at altitudes far beyond the limits which can be assigned with any probability to the atmosphere, have rendered this supposition altogether untenable. Another hypothesis respecting their origin is, that they are bodies projected to our earth from volcanoes in the moon. Dr. Olbers was the first, perhaps, who showed the possibility of this hypothesis. On computing the forces necessary to overcome the moon's attraction, he found that a body projected from the moon with a velocity of about 8500 feet in a second would not fall back on the lunar surface, but recede from it indefinitely; and that in order to reach the earth it is only necessary that the projectile should have the velocity of 8500 feet, which is quite conceivable, being only about four or five times that of a cannon ball. The hypothesis of the lunar origin of meteoric stones was adopted by Laplace, Berzelius, Benzenburg, and others; but the observed velocities of the shooting stars have rendered this origin extremely improbable with respect to them. In order to enter our atmosphere with a velocity of 20 miles in a second, it may be shown that if they come from the moon they must have been projected from the lunar surface with a velocity of about 120,000 feet in a second, which may be regarded as altogether impossible.

It thus appears that those shooting stars and fire-balls which have the planetary velocity of from 20 to 40 miles in a second, cannot with any probability be regarded as having their origin in the moon. Whether any individual bodies moving with a smaller velocity may have a lunar origin, is a question which cannot be decisively answered. "To me," says Dr. Olbers, "it does not appear at all probable; and I regard the moon, in its present circumstances, as an extremely peaceable neighbour, which, from its want of water and atmosphere, is no longer capable of any strong explosions."

The hypothesis first suggested by Chladni is that which appears to have met with most favor, having been adopted by Arago and other eminent astronomers of the present day to explain the November phenomena. It consists in supposing that, independently of the great planets, there exist in the planetary regions myriads of small bodies which circulate about the sun, generally in groups of zones; and that some of these zones intersect the ecliptic, and are consequently encountered by the earth in its annual revolution. The principal difficulties attending this theory are the following:—First, that bodies moving in groups in the circumstances supposed must necessarily move in the same direction, and consequently, when they become visible from the earth, would all appear to emanate from one point and move towards the opposite. Now, although the observations seem to show that the predominating direction is from north-east to south-west, yet shooting stars are observed on the same nights to emanate from all points of the heavens, and to move in all possible directions. Secondly, their average velocity (especially as determined by Wartmann) greatly exceeds that which any body circulating about the sun can have at the distance of the earth. Thirdly, from their appearance, and the luminous train which they generally leave behind them, and which often remains visible for several seconds, sometimes for whole minutes, and also from their being situated within the earth's shadow, and at heights far exceeding those at which the atmosphere can be supposed capable of supporting combustion, it is manifest that their light is not reflected from the sun; they must therefore be self-luminous, which is contrary to every analogy of the solar system. Fourthly, if masses of solid matter approached so near the earth as many of the shooting stars do, some of them would inevitably be attracted to it; but of the thousands of shooting stars which have been observed, there is no authenticated instance of any one having actually reached the earth. Fifthly, instead of the meteors being attracted to the earth, some of them are observed actually to rise upwards, and to describe orbits which are convex towards the earth; a circumstance of which, on the present hypothesis, it seems difficult to give any rational explanation.

From the difficulties attending every hypothesis which has hitherto been proposed, it may be inferred how very little real knowledge has yet been obtained respecting the nature of the shooting stars. It is certain that they appear at great altitudes above the earth, and that they move with prodigious velocity; but every thing else respecting them is involved in profound mystery. From the whole of the facts, M. Wartmann thinks that the most rational conclusion we can adopt is, that the meteors probably owe their origin to the disengagement of electricity, or of some analogous matter, which takes place in the celestial regions on every occasion in which the conditions necessary for the production of the phenomena are renewed.

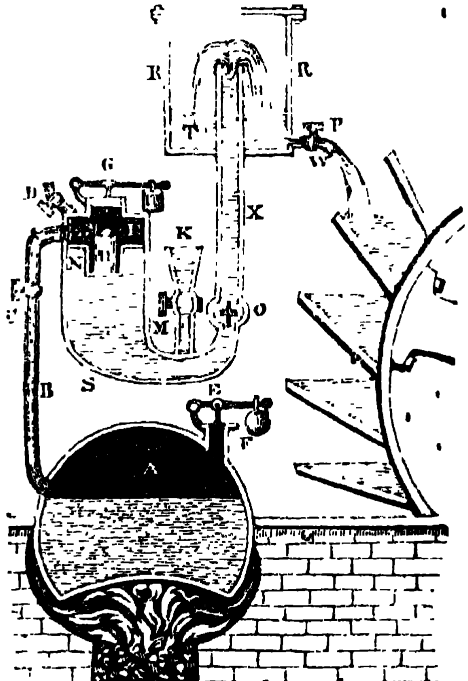
The presumptions in favor of the cosmical origin of the shooting stars are chiefly founded on their periodical recurrence at certain epochs of the year, and the extraordinary displays of the phenomena in various years on the nights of the 12th or 13th of November. We shall here merely state the principal circumstances accompanying those of 1799, which put the notion of a *lunar* origin entirely out of the question.

On the morning of the 12th of November, 1799, before sunrise, Humboldt and Bonpland, then on the coast of Mexico, were witnesses to a remarkable exhibition of shooting stars and fire-balls. They filled the part of the heavens extending from due east to about 30° towards the north and south. They rose from the horizon between the east and east-north-east points, described arcs of unequal magnitude, and fell towards the south; some of them rose to the height of 10°, all above 25° or 30°. Many of them appeared to explode, but the larger number disappeared without emitting sparks: some had a nucleus apparently equal to Jupiter. This most remarkable spectacle was seen at the same time in Cumana, on the borders of Brazil, in French Guiana, in the channel of Bahama, on the continent of North America, in Labrador, and in Greenland ; and even at Carlsruhe, Halle, and other places in Germany, many shooting stars were seen on the same day. At Nain and Hoffenthal in Labrador, and at Newhernhut and Lichtenau in Greenland, the meteors seem to have approached the nearest to the earth. At Nain they fell towards all points of the horizon ; and some of them had a diameter which the spectators estimated at half an ell.

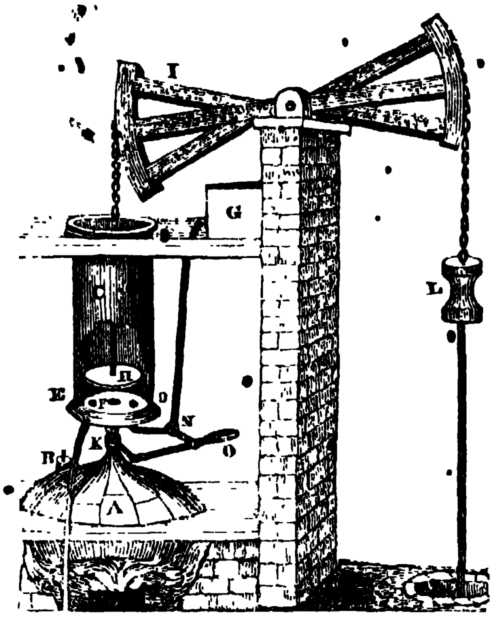
STEAM AND THE STEAM ENGINE

(Resumed from page 350.)

It has been already stated, that Dr. Papin had, previous to the practical development of Savory's projects, employed his faculties upon the then known properties of steam ; yet, evidently, Savory was the first to construct a working and useful steam engine ; therefore, although the French claim for their countrymen the merit of this noble machine, yet we must admit, that our countryman has deservedly the preference, and this is admitted by all nations except the French. The expansive force of steam, however, which Papin had previously explained, although not the great power employed, seems for many years to have led to no result ; in fact, Papin had abandoned the experiments he had at first instituted as leading to no result, until the celebrated Leibnitz, having seen one of Savory's engines in England, sent a description and draught of it to Papin for his opinion upon its merits ; then and not till then did Papin set his inventive faculties to bear successfully upon the subject. After a time, namely, in 1707,—he published a pamphlet, called, a "New method of raising Water by the force of Fire." In this pamphlet he described the following engine .—



A boiler A, made of copper, communicates by a pipe B, with a cylinder I, which forms the body of the pump. This cylinder has no bottom, but is connected to the curved pipe X, which enters into and ascends, nearly to the top of the cistern R R, which is air-tight, and is furnished with a pipe and cock P W. On the curved part of the pipe X is another pipe terminating with the funnel K, and having a stop-cock M. The feeding pipe B, has also a stop-cock C, and just above is another pipe D. At Q is a conical valve, and at G a safety valve. Also a second safety valve is at E on the boiler. When a sufficient quantity of steam is generated in the boiler A, the cock C is opened, to allow it to flow into the pump cylinder I, which we may suppose to be nearly filled with water, the steam presses by its elasticity upon the floater H ; and depresses it into the cylinder I, forcing the water which is beneath it, through the curved pipe S, up the pipe X, till it falls into R R. The cock P is then opened, and the water compressed by the condensed air in the upper part of the cylinder, issues with great velocity upon the float boards of the wheel to which it imparts motion. The reverse action obtained by the alteration of the cocks will be easily understood. A curious contrivance will be found in the floater of this engine. Papin was desirous at the same time of preventing the condensation of the steam sent into the cylinder, and also to promote its elasticity ; with this view the floater had on its upper part a case or cylinder of iron, in which a red hot iron H was placed, so that the steam instead of coming in contact with cold water, struck against the heated iron, and thus acted with increased instead of diminished force in the water cylinder. The heated irons were renewed from time to time through the valved orifice C. The trouble attending such a contrivance rendered it inefficacious, still its ingenuity will be readily conceded, as well as the merit of the safety valve in the boiler, the want of which was severely felt in Savory's engines. Another thing is worthy of remark, that is, the near approach of the floater of Papin's cylinder to the piston afterwards employed, and also the circumstance that when the steam is cut off, and the communication with M, which is supposed to be connected with the well, is opened, the plunger is driven up again by the pressure of the air within R R. These things it is said by some writers suggested the structure of the *atmospheric engine*, afterwards invented by Newcomen ; yet it does not clearly appear that this latter person, who was a blacksmith at Dartmouth, in Devonshire, was at all acquainted with the works of Papin. If he had, it is scarcely possible to suppose that he would have omitted to use the lever safety valve, yet we do not find it in the engines of Newcomen, a clack valve being substituted. In Savory's engine we have seen that the effect is produced in two ways, by the condensation of the steam forming a vacuum in a receiver, into which the water is forced by the pressure of the atmosphere, and where the water was required to be elevated to a greater height than from 28 to 30 feet, he employed the direct pressure of steam of a higher temperature and dangerous elasticity. In the atmospheric engine, the process is totally different, the steam exerts no direct action upon the water, or upon any part of the apparatus—it is merely employed as a means of forming a speedy vacuum, under a piston attached to one end of a lever, the rod of a pump, piston, or plunger being attached to the other end. In this construction the power of the engine has no reference whatever to the strength or temperature of the piston, beneath which the vapor is introduced from the boiler. The steam cylinder is now for the first time detached from the water pump.



The steam generated in a boiler A, was admitted through the cock K, into a cylinder C, under the piston H, attached by a rod or chain to one end of the beam L. The other end of the beam bearing a rod which is attached to a common pump. A bent pipe D reached from a cistern G, to the bottom of the cylinder, a second pipe reached to the well; it is shown in the figure as if crossing the fire. The engine was worked by a boy whose business was to move the handle O backwards and forwards. The handle moved at the same time two cocks K and N. One of which it turned on and the other off at the same time; now supposing that the boy pulled the handle towards him, it would close N and open K. By this action, the steam would rush beneath the piston, and driving it up, would suffer the pump rod to sink, being forced down by the weight J. When the cylinder is full of steam, the handle O is pushed back, and the steam thereby cut off, while the cock N being turned on, a stream of cold water rushes into the cylinder and condenses the steam; the piston therefore falls, being acted upon by the pressure of the atmosphere on the upper side of it, the waste water runs of by the second pipe. This engine is still used as a pumping engine.

(To be continued.)

PRESERVATION OF FISH.

In preserving fish for the purposes of science, no method is preferable to that of immersing them in spirits. The mouth, gills, and fins can then be spread open; the rays of the one and the internal parts of the other can be accurately examined, and even the internal structure of the body may be investigated. All these advantages are either partially or totally lost to the naturalist when the specimens have been either stuffed or dried. It is therefore advisable to preserve all such species as may require subsequent examination in spirits. Of the vessels to be used for fish and other animals, glass bottles are perhaps the best, as, whatever precautions are used, a portion of the liquor will evaporate through the pores of wooden casks: square bottles are to be preferred, as they arrange close in cases, and no space is lost. The perfect preservation of the animal depends upon the quality of the liquor, the manner of placing them in the bottles, and the method of luting or closing these bottles. The following instructions under these heads are taken from the memoir of the celebrated circumnavigator Peron, whose voyages have been attended with more advantage to natural science than any others on record.

The spirituous liquor to be used must be from 16 to 22° of the areometer of Baumè; (this is from the strength of brandy or whiskey, to that of ordinary gin,) if it be stronger, it entirely destroys the color of the subjects. For quadrupeds it should be of 22° All spirituous liquors are equally good, but those which have least color are obviously preferable. Before the fish or animal is put in the liquor, it should be cleaned from dirt and slime. It is desirable to prevent it from touching the bottom of the bottle, as, if not supported, it will sink down and soon become corrupted. M. Peron therefore proposes to fasten the animal to a flat piece of cork, which holds it suspended in the liquor. Several subjects can thus be placed in the same vessel, either by the side of one another or at different heights; they will float in the liquor without touching, and the slimy particles will become detached and fall to the bottom. M. Peron affirms that thus floating they cannot be injured, although the bottle may be shaken or overturned. But as this method is not very easy, the specimen may be inclosed in a bag of very fine linen, or in a net tied to the cork, to which they will remain suspended. With vertebrated animals it will be advisable to make a small incision in the body, that the liquor may penetrate into the inside. M. Peron advises the use of camphorated spirits, as the camphor augments the preserving quality of the liquor. In some cases, however, this is attended with the disadvantage of making the subjects tough and difficult to dissect. After the animal has been in some days, the bottle must be replenished with liquor, and then firmly closed with a cork-stopper: those made of glass frequently break by the evaporation of the spirits.

The luting or composition with which the cork is to be covered, and the evaporation prevented, is called by M. Peron lithocolle; it is composed of the following ingredients:—common resin, red ochre well pulverized, yellow wax, and oil of turpentine. The wax and resin is melted, and the ochre added in small portions, stirring it briskly at each addition with a spoon. When the mixture is boiled seven or eight minutes, pour in and mix the oil of turpentine, and continue to boil the whole. Precautions must be taken to prevent the inflammation of these ingredients; but if this should happen, a lid to cover the vessel must be at hand, with which the flame may be immediately extinguished: the vessel should moreover be furnished with a handle, and capable of containing three or four times the quantity of luting that is actually preparing. To ascertain its quality, a small quantity may be put from time to time upon a cold plate, and its degree of tenacity can thus be ascertained. This cement can be prepared at sea, and employed almost immediately. After having corked the bottles, and wiped them well with a dry cloth, the cement is heated to the boiling point, and being well stirred, is applied over the whole surface of the cork by a brush or any other substitute. Sometimes the cement, by penetrating the cork, causes the spirits to evaporate and burst the surface; this causes small openings to appear, which are stopped by passing a second coat of lithocolle over the first when it is cold. If the bottles are small, the necks may be at once plunged into the cement, provided the grain of the cork is of such a close texture as to prevent any of the spirit from passing through during the operation. The aperture of the bottle may be further secured by covering it again with linen, firmly tied and saturated with liquid pitch. Bottles thus prepared may be turned over in all directions, and exposed to the strongest atmospheric heat without the least evaporation or escape of the spirits.

The skins of fish may be preserved and dried by different processes. The most simple method, applicable to the greatest proportion, is that of dividing the fish longitudinally, so as to preserve one side of the skin and fins in an entire state; from this side the internal bones and flesh are removed. The head is sufficiently reduced in thickness to admit of being laid flat; in other words, accurately divided into two: the dorsal and caudal fins must of course be left entire, as they are too thin to be divided. The skin and bones being well anointed with the preservative, may be either filled with plaster and attached to a board, or be suffered to dry between leaves of blotting paper, and preserved like dried plants.

Lampreys, eels, and other cylindrical fish may be preserved by skinning them from the head to the tail, in the same manner as eels are prepared for cooking. The head, however, must be preserved, its contents emptied, and the skin filled with fine sand. The diodons, ostracions, and several other exotic tribes, having their bodies covered with spines or bony scales, are to be opened longitudinally under the belly; the interior parts are then removed. and by being simply stuffed with cotton, the original form is preserved unchanged.

GOTHIC ARCHITECTURE.

THIS term is considered by some authors to include the Romanesque, Saxon, Norman, or by whatever other name the early Christian style, distinguished by its massive character and circular arches, may be called; but it is now generally understood as distinct from it, and is thus admirably defined by Mr. Whewell :—"It is characterised by the *pointed arch;* by pillars which are extended so as to lose all trace of classical proportions; by shafts which are placed side by side, often with different thicknesses, and are variously clustered and combined. Its mouldings, cornices, and capitals, have no longer the classical shapes and members; square edges, rectangular surfaces, pilasters and entablatures, disappear; the elements of building become slender, detached, repeated, and multiplied; they assume forms implying flexure and ramification. The openings become the principal parts of the wall, and the other portions are subordinate to these. The universal tendency is to the predominance and prolongation of *vertical lines;* for instance, in the interior, by continuing the shafts in the arch-mouldings; on the exterior, by employing buttresses of strong projection, which shoot upwards through the line of parapet, and terminate in pinnacles. The pier is, in the most complete examples, a collection of vertical shafts surrounding a pillar, of which the edges are no longer square. The archivolt consists of members corresponding more or less to the members of the pier, and consequently is composed of a collection of rounds and hollows, and loses all trace of its original rectangular section. The piers send up vaulting shafts, which give an independent unity to the compartment which they bound: and the clerestory window and its accompaniment have a necessary relation to the symmetry of this compartment: the triforium of course conforms to the same rule. At the same time, the workmanship improves much, both in skill and taste, and carries the predominating character into the details."

But all these changes were introduced gradually in the course of several centuries, and the Gothic style has, consequently, been divided into three distinct periods. The first style of Gothic in this country, called by Mr. Rickman the early English, prevailed throughout the thirteenth century. The decorated style, or perfect Gothic, prevailed during the greater part of the fourteenth century. The third and last style, called by Mr. Rickman the perpendicular, may be called the style of the fifteenth century; but specimens may be found as late as 1640, and even later, though often much debased, and mixed with the Italian style, then prevalent.

It has been well observed by Mr. Willis, that the complete Gothic style did not arise at once from the Romanesque; but that, on the contrary, there is in every country a different intermediate style, which has been called early Gothic, but we may substitute the name of each country as a distinction; thus we have early English, early German, early French, and we may add, early Italian. In Italy the Gothic was at once superseded by the revived Classical, but in other countries it had time to decline into forms which may be termed the after Gothics, and which in Germany, the Netherlands, France, and England, constitute as many different styles, although derived from a common parent. In the two latter they have been termed flamboyant and perpendicular, from the forms of the tracery in the windows, and were all eventually superseded by the revived Classical, which spread itself from Italy over the whole of Europe.

INERTIA.

INERTIA means passiveness or inactivity. Thus, matter is, of itself, equally incapable of putting itself in motion, or of bringing itself to rest when in motion.

It is plain that a rock on the surface of the earth never changes its position in respect to other things on the earth. It has of itself no power to move, and would therefore for ever lie still, unless moved by some external force. This fact is proved by the experience of every person, for we see the same objects lying in the same positions all our lives. Now, it is just as true that inert matter has no power to bring itself to rest, when once put in motion, as it is, that it cannot put itself in motion, when at rest; for, having no life, it is perfectly passive, both to motion and rest, and therefore either state depends entirely upon external circumstances.

Many instances might be given of the unwillingness of matter to yield to any impression given to it, and its tendency to remain quiescent. The following are among the most instructive :—When the sails of a ship are loosened to the breeze, slowly and heavily at first the vessel gets into motion, but gradually its speed increases as the force by which it is impelled overcomes the inertia of her mass.

A great force is necessary at first to set a vehicle in motion; but when once this is effected, it goes onward with comparative ease, so that, in fact, a strong effort is necessary before it can be stopped. If a person be standing in it when it is suddenly set a-going, his feet are pulled forward, whilst his body, obeying the law of inertia, remains where it was, and he accordingly falls backwards. On the other hand, if the vehicle be suddenly stopped, and the individual be standing in the same position as formerly, the tendency which his body has to move forward—for it acquired the same motion as the carriage by which it was borne along—will cause him to fall in the opposite direction. Casualties of this description frequently occur to persons on horseback, who are thrown over the necks of their steeds, or fall behind them, according as the animal stands still suddenly, or starts off unexpectedly. A man jumping from a coach at full speed will certainly fall prostrate on the ground, if he leaps down as if he were descending from a body at rest, to one which is in the same state; for when he makes the attempt, his body has the same motion as the coach; and when the feet arrive at the ground, the motion in the lower part is arrested, whilst it continues in the upper part; and thus he finds himself thrown from the perpendicular into the horizontal position.

The following is a familiar example of the inertia of matter:—Upon the tip of the finger let a card be balanced, and a piece of money—say a shilling—laid upon it. Let the card then be smartly struck, and it will fly from beneath the coin, leaving it supported upon the finger. This arises from the inertia of the metal being greater than the friction of the card which passes from beneath it.

Coursing, or hare hunting, affords a striking illustration of inertia. In that cruel sport, the hare seems to possess an instinctive consciousness of the existence of this law of matter. When pursued by the greyhound, it does not run in a straight line to the cover, but in a zig-zag one. It *doubles*, that is, suddenly changes the direction of its course, and turns back at an acute angle with the direction in which it had been running. The greyhound, being unprepared to make the turn, and therefore unable to resist the tendency to persevere in the rapid motion which it has acquired, is impelled a considerable distance forward before it can check its speed and return to the pursuit. But, in the meantime, the hare has been enabled to shoot far ahead in the other direction; and although a hare is much less fleet than a greyhound, by this scientific manœuvring it often escapes its pursuer. Those who have witnessed the perhaps still more cruel practice of horse-racing, may have observed that the horses shoot far past the winning-post before their speed can be arrested. This is also owing to the inertia of their bodies.

Common experience proving that matter does not put itself in motion, we might be led to believe that rest is the natural state of all inert bodies; but a few considerations will show that motion is as much the natural state of matter as rest, and that either state depends on the resistance, or impulse, of external causes.

If a cannon-ball be rolled upon the ground, it will soon cease to move, because the ground is rough, and presents impediments to its motion; but if it be rolled on the ice, its motion will continue much longer, because there are fewer impediments, and, consequently, the same force of impulse will carry it much farther. We see from this, that, with the same impulse, the distance to which the ball will move must depend on the impediments it meets with, or the resistance it has to overcome. But suppose that the ball and ice were both so smooth as to remove as much as possible the resistance caused by friction, then it is obvious that the ball would continue to move longer, and go to a greater distance. Next, suppose we avoid the friction of the ice, and throw the ball through the air, it would then continue in motion still longer with the same force of projection, because the air alone presents less impediment than the air and ice, and there is now nothing to oppose its constant motion, except the resistance of the air.

If the air be exhausted, or pumped out of a vessel by means of an air-pump, and a common top, with a small hard point, be set in motion in it, the top will continue to spin a considerable length of time, because the air does not resist its motion. A pendulum, set in motion in an exhausted vessel, will continue to swing, without the help of clockwork, for a whole day, because there is nothing to resist its perpetual motion but the small friction at the point where it is suspended.

We see, then, that it is the resistance of the air, and of friction, and of gravitation, which causes bodies once in motion to cease moving, or come to rest; and that dead matter, of itself, is equally incapable of causing its own motion, or its own rest.

IMITATION OF COGNIAC BRANDY.

English spirits, with proper management, are convertible into brandy that shall hardly be distinguished from foreign, in many respects, provided the operation is neatly performed. The best, and indeed the only method of imitating French brandies to perfection, is by an essential oil of wine; this being the very ingredient which gives the French brandies their flavor. It must, however, be remembered, that in order to use even this ingredient to advantage, a pure tasteless spirit must first be produced; for it would be absurd to expect, that this essential oil should be able to give the agreeable flavor of French brandy to our malt spirit, already loaded with its own oil, or strongly impregnated with a lixivious taste from the alkaline salts used in rectification.

To prepare the oil of wine, dissolve some cakes of dry wine-lees in six or eight times their weight of water, distil the liquor by a slow fire, and separate the oil by a separatory glass, reserving for the nicest uses that which comes over first, the succeeding oil being coarser and more resinous. This oil of wine may be dissolved in alcohol; by which means it will, for a long time, be fully possessed of all its flavor; but otherwise it will soon grow rancid.

The essential oil, however, must be drawn from the same kind of lees as the brandy, to be imitated, was procured from: that is, in order to imitate cogniac brandy, it will be necessary to distil the essential oil from cogniac lees; and the same for any other kind of brandy. For as different brandies have different flavors, and as these flavors are entirely owing to the essential oil of the grape, it would be preposterous to endeavour to imitate the flavor of cogniac brandy with an essential oil procured from the lees of Bourdeaux wine. After the flavor of the brandy is well imitated by a proper dose of the essential oil, and the whole reduced into one simple and homogeneous fluid, other difficulties still remain: the color, the proof, and the softness, must also be regarded, before a spirit that perfectly resembles brandy can be procured. With regard to the proof, it may be easily accomplished, by using a spirit rectified above proof; this, after being intimately combined with the essential oil of wine, may be reduced to a proper standard by distilled water. The softness may, in a great measure, be obtained by distilling and rectifying the spirit over a gentle fire; what is wanting in this criterion, when the spirit is first made, will be supplied by time: for it must be remembered, that it is time alone that gives this property to French brandies, as at first they are acrid and fiery. Treacle, or burnt sugar, gives the spirit a fine color, nearly resembling that of French brandy; but as its color is deep, a large quantity must be used. This is not, however, attended with any bad consequences; for notwithstanding that the spirit is really weakened by this addition, yet the bubble-proof, (the general criterion of spirits,) is greatly heightened by the tenacity imparted to the liquor by the treacle. The spirit acquires from the mixture a sweetish or luscious taste, which renders it very agreeable to some palates. A much smaller quantity of burnt sugar, than of treacle, will be sufficient for coloring the same quantity of spirits: the taste also is very different; for, instead of the sweetness imparted by the treacle, the spirit acquires from the burnt sugar an agreeable bitterness, and by that means, recommends itself to many who dislike a luscious spirit. The burnt sugar is prepared by dissolving a proper quantity of sugar in a little water, and scorching it over the fire till it acquires a black color.

The spirit distilled from molasses, or treacle, is very pure. It is made from common treacle dissolved in water, and fermented in the same manner as the wash for the common malt spirit. But if some particular art is not used in distilling this spirit, it will not prove so vinous as malt spirit, but more flat and less pungent, though otherwise much better tasted, as its essential oil is of a less offensive flavor. Therefore, if fresh wine-lees, abounding in tartar, are well fermented with molasses, the spirit will acquire a greater vinosity and briskness, and approach much nearer to the nature of foreign brandy. If the molasses-spirit, brought to the common proof-strength, is found not to have sufficient vinosity, it will be proper to add some sweet spirits of nitre; and if the spirit has been properly distilled by a gentle heat, it may, by this addition only, be made to pass, with ordinary judges, as French brandy. Great quantities of this spirit are used in adulterating foreign brandy, rum, and arrack. Much of it is also used, alone, in making cherry-brandy and other cordials by infusion; in all which, many, and perhaps with justice, prefer it to foreign brandies. Molasses, like all other spirits, is entirely colorless when first extracted; but distillers always give it, as nearly as possible, the color of foreign spirits.

PREPARATION OF PYROLIGNEOUS ACID.

Place a large cast-iron cylinder, or retort (similar to those used for the production of carburetted hydrogen gas,) in a furnace, so that it may receive as much heat, all round, as possible. One end of this cylinder must be so constructed as to open and shut, to admit wood and exclude the air

Oak in pieces about a foot in length is to be put into the cylinder, which is to be filled as full as possible, without being wedged, and the door must be shut close to exclude air. From the cylinder let a worm run through cold water to condense the acid; by this it is conveyed to a large cask placed on one end where there is a pipe to carry it from that to two or three more; thus it is completely secured from flying off in the vaporous state. The fire is now to be raised to a great heat, sufficiently powerful to convert the wood completely into charcoal. When the acid ceases to come over, the fire is to be taken out, and the mass of wood left to cool in the confined state, when it becomes perfect charcoal. In the first cask tar is chiefly contained with the acid, it precipitates to the bottom, and is drawn off by a cock; it is afterwards boiled in an iron boiler to evaporate the acid, before it is fit for use. If the acid is not strong enough, it is put into large square vats about six inches deep, for the purpose of making a large surface, to evaporate a part of the water contained in the acid more speedily by a slow heat. These vats are bedded on sand upon the top of a brick stove, where a gentle heat is applied; thus it may be procured in a pretty strong state.

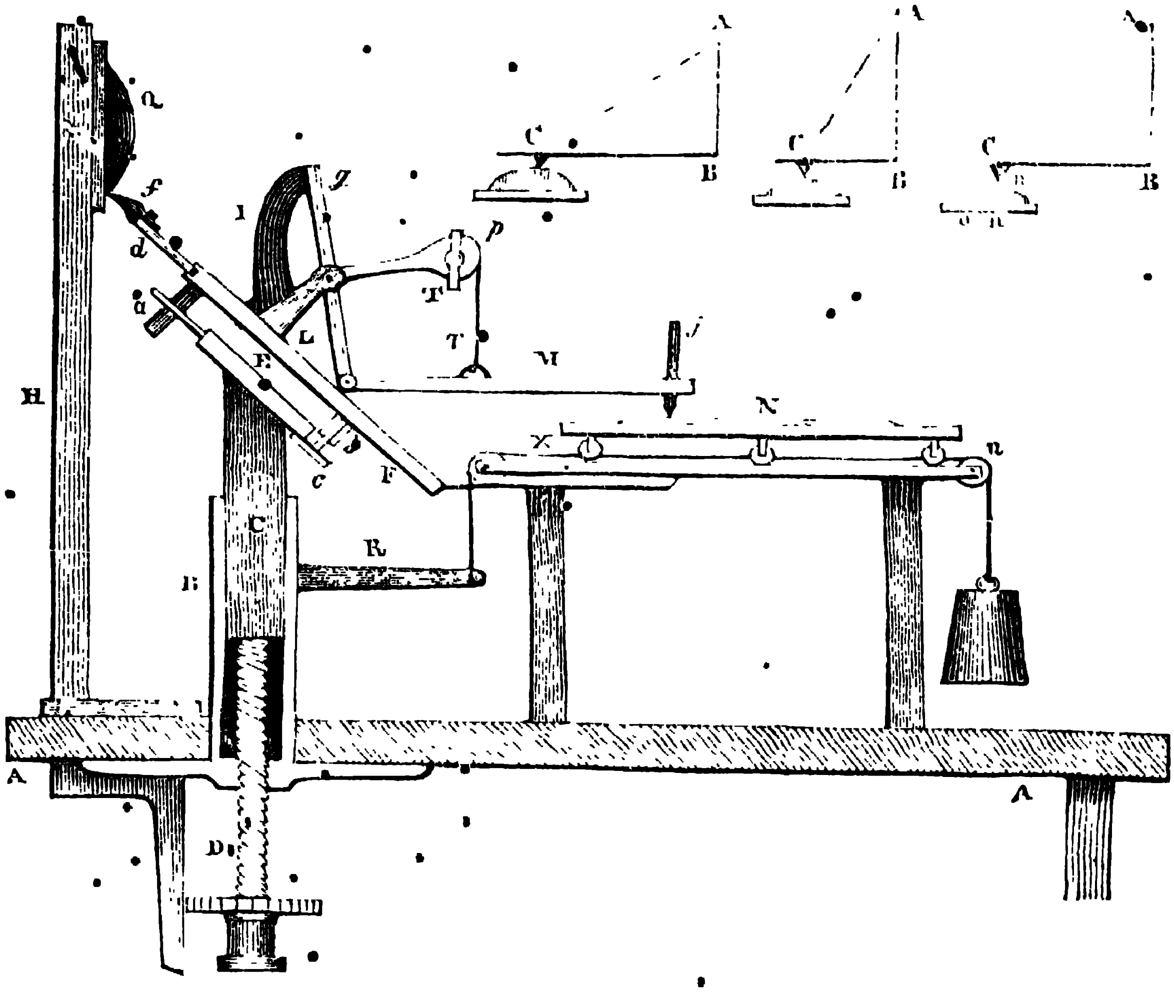
MEMORANDA.

To Transfer Engravings to Plaster Casts.—Cover the plate with ink, and polish its surface in the usual way, then put a wall of paper round it, and when completed, pour in some finely powdered plaster of Paris, mixed in water; jerk the plate repeatedly, to allow the air bubbles to fly upwards, and let it stand one hour, then take the cast off the plate, and a very perfect impression will be the result.

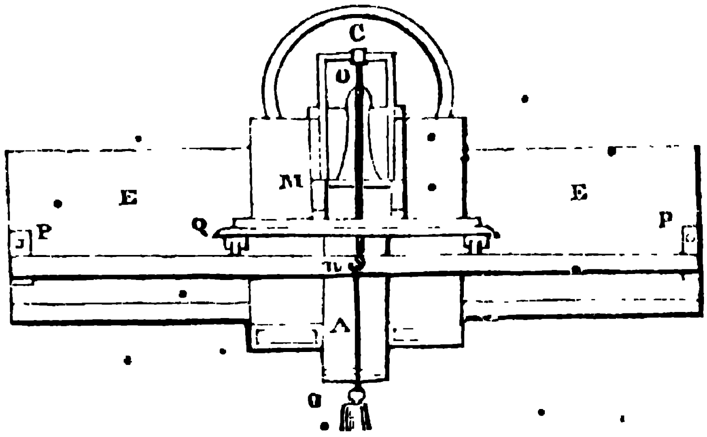
Spots on the Sun.—Herschel supposes the spots in the sun are mountains on its surface, perhaps above 300 miles high. On examining the sun with several powers from 90 to 500, the black spots seemed the opaque ground or body of the sun; and the luminous part an atmosphere, intercepted or broken. If one of the spots appears upon the eastern limb or edge of the sun's disc, it moves thence to the western edge in 13½ days; it then disappears, and in about 13½ days more, is seen again upon the eastern edge; and so continues, completing its revolution in about 27 days. In 1779, Herschel measured a spot in the sun 50,000 miles in diameter. These spots cross the sun from east to west, and show that the axis is inclined 3° 45′ to the eastward. Spots have been seen to divide and separate in many parts. They frequently make notches in the sun's limb. When they disappear, they are succeeded by faculæ or bright spots. They are classed as openings, shallows, ridges, nodules, corrugations, indentations, and pores.

Daily Temperature.—The mean daily course of the temperature of the atmosphere is the same at all hours. According to a yearly mean the coldest hour of the day in Europe is 5 o'clock in the morning. The warmest hour of the day is from 2 to 3 in the afternoon. The rise is most considerable some hours after the minimum, the fall some hours after the maximum. The heat increases for 9-10 hours, decreases for 14-15 hours. The greatest daily range of temperature in Europe is about 30° F. The greatest daily range of temperature in Europe takes place in July, and the least in December.

Fig. 1. 3. 4.



BATES'S ANAGLYPTOGRAPHY; OR, MACHINE FOR MEDALLIC ENGRAVING.



2.

BATES'S ANAGLYPTOGRAPHY · OR, MACHINE FOR MEDALLIC ENGRAVING.

THE object of this invention is to produce facings, engravings, or correct representations of busts, medallions, medals, seals, or other objects in relief, on a plain surface, in a more correct and perfect manner than has hitherto been done by tracing or engraving machines; and is particularly designed to prevent the distortion of the features of the bust, or of the subject to be copied, at the same time producing the desired effect, to represent a subject in relief. Fig. 1, represents a side elevation of these improvements on machinery applicable to the imitation of medals, sculpture, and other works of art executed in relief: A A, represents a board or table; and B, shows a vertical section of a brass socket fixed thereto; C, is a square brass standard, made to slide up and down within the socket, being very accurately fitted; D, is a steel screw, having a micrometer attached at its lower end, by which means it can be turned so as to move the standard C, at equal distances, either ascending or descending; E, shows a plate of metal fixed to the standard C, and inclined to the horizontal plane of the table or board A A, at an angle of 45°. The upper edge of this plate has a groove formed in it, to receive two bevelled rollers of a carriage now to be described; F, represents a carriage, which moves very freely on the plate E, by means of three rollers, two of which are bevelled, so as to enter the groove formed to receive them, on the upper edge of the plate E. In this view, only one of the bevelled rollers A, can be seen, the other being immediately behind it. These rollers are made with long axes, and very accurately fitted in their bearings, so as to move freely without shaking. The lower part of this carriage is supported, and moves on a single roller B, the axis of which is placed at right angles to those already described, the periphery revolving and resting upon the ledge C; D, represents a sliding plate, which is made very true, and parallel on two of its edges; and these are bevelled on each side, so as to produce a double prism; the bevelled edges so formed enter the grooves of four rollers, fixed in the carriage F.

By these means the sliding plate D D, is made to move very freely, and yet with great accuracy; F, represents a point, fixed to the sliding plate D D; this is used to trace over any medal, or other suitable work of art that is required to be copied; G, shows a section of a portion of a sphere, rising from a plane surface, and similar to a medal in its general form. Any such subject may be fixed to the supporting frame H, by any suitable cement, care being taken that its plane be placed in a proper position, I, is a metal guide, fixed at its lower end to the sliding plate D; the upper portion of this is formed into a straight edge at G, and stands perpendicular to A A; I, represents a vibrating lever, the arms of which are equal; this swings freely on two conical points, one of which is seen in the arm fixed upon the carriage F. The upper end of the vibrating lever has a friction roller placed in it, which is always kept in contact with the straight edge of the guide G, by a spring, while the lower end of the lever moves the frame M, at the end of which the diamond point is fixed, as shown at J, perpendicular to the surface of the copper-plate N, which lies parallel with A A.

One end of the point frame M, is jointed on each side to the lower end of the vibrating lever, forming an elbow joint therewith, the pivots or bearings being made conical, so as to avoid friction as much as possible; P, represents a small barrel, fixed on an axis, one end of which turns in the end of a projecting arm, and is retained in any position by friction; the other end has a flat button formed on it, by which it may be turned: R, shows a small silk cord; one end of this is coiled round the barrel P, and the other is attached to the point frame M.

By these means the diamond point may be raised from the plate, and kept suspended at pleasure: X, represents the plate carriage, which has three friction rollers placed in frames under it. Two of these rollers are bevelled, and run in a groove formed in an underplate: the other roller is plain, and rolls on the surface of the same metal plate; There is a cord made fast at one end to the stud R, and passing over the pulley N, it hangs down, and has the weight O, appended to it; by which means the carriage will be drawn along whenever C is lowered by the micrometer screw D.

When this machine is to be used, the micrometer screw D, should be placed in the centre of its range, and then the medal, or other object to be traced over, must be placed at such a height that the tracing point F, may be brought just in contact with the centre of the medal; the copper plate N must at the same time be placed immediately under the diamond point, with its edges parallel to the plate X. The machine and plate being thus adjusted, the micrometer screw D, must be made to raise the standard C, and all the parts combined therewith, until the tracing point F, will nearly reach the top of the medal or other subject. The tracing point F, must then be laid hold of by the hand, and brought into contact with the surface at S, (moving the screw D, as may be required, to bring the tracing plate into its mean position,) by means of the combined motions of D and F. The machine will then be in the proper position for beginning the first line, when the button must be turned, and the diamond point gently let down upon the copper plate; and the tracing point F, being then passed very carefully over that part of the medal which presents itself to it, the diamond point will be found to have etched a line on the copper plate, exactly corresponding to the undulations which the tracing point has passed over on the medal. The diamond point must then be raised from the plate, and the micrometer screw must be turned, so as to produce such a space between the lines on the copper plate as may have been previously determined upon, and the same movements repeated, until the whole surface of the medal has been traced over. When sculpture or other works of art are to be traced over, and the undulations of the tracer transmitted to a plate, so as to produce a copy thereof, such works must be placed before the tracer F, in a vertical position; and the mode of setting and adjusting the machine, and also the copper plate, must be adopted, as before described; and then if the tracer F, be made to pass over every part that the tracing point will reach, such undulation will be transmitted to the copper-plate, and a correct representation will be the result.

Fig. 2, represents a front view of Fig. 1, the same letters of reference being placed upon the same parts wherever they can be seen. In this figure the standard is omitted, and also the micrometer screw by which it is moved. In former constructions, the tracing point is moved in a plane perpendicular to the plane of the medal. Now, in the improved construction, the tracing point moves in a plane oblique to the plane of the medal, or, in other words, oblique to the plane in which C moves; and the principle of the correction consists in making the line described upon the copper, (which is straight, so long as the tracer describes the plane of the medal, and becomes diverted from the straight line, as the tracer rises above this plane), be diverted an equal quantity from the straight line upon the copper, as the tracer is diverted from a plane perpendicular to the plane of the medal. The relative direction of the motions required to produce this effect may be described by any right-angled triangle; one motion being in the plane of the base, a second in the plane of the perpendicular, and a third in the plane of the hypothenuse, or in planes parallel to these several planes respectively; and the proportion of apparent elevation in the engraving will be to the elevation in the medal itself, as the proportion of the base of the triangle to its perpendicular.

In the triangles, 3, 4, 5, the motion represented by A B, is effected in the machine by the edge g; that represented by A C, is effected by the sliding plate D, and the motion represented by B C, is given in the plane surface N; also in Fig. 5, where the base and perpendicular are equal, the engraving will appear as much elevated as in the medal itself: in Fig. 4, where the base is half the perpendicular, the engraving will appear to have only half the elevation of the medal; and in Fig. 3, where the base is double the perpendicular, the engraving will appear to have double the elevation of the medal.

The Patentee concludes by saying, "I hereby declare, that whether the machinery or apparatus, shown in the figures that is used to shift the tracing point equal distances) moves either vertically, horizontally, or in any other direction, my invention consists in making the tracing point move and operate upon the medal, or other work of art, in a plane oblique to such motion, that being the principle wherein my invention differs from all other machinery now used for producing similar effects."

[It may as well be observed, that the title page of the "Dictionary of Arts and Sciences," is an illustration of this method of engraving; indeed, it was executed by the very machine now described. The plate of copper or steel has an etching ground laid upon it, the lines are then drawn as described, and finally they are bitten in, as in etching.—ED.]

BUTTERFLIES.

THE term butterfly is a literal translation of the Saxon word, *Butter-fieoze*, and is supposed to be applied because the insects first become prevalent in the beginning of the season for butter. They are distinguished from the other scaly-winged kinds, by possessing antennæ with a knob or club at the summit, and holding their wings, when in a state of repose, erect or very slightly inclined. They are the most generally and familiarly known of our insect tribes, and by their conspicuous appearance, seldom fail to attract the notice of even those whose perceptions are least alive to the beauty of natural objects. The graceful curves of their outline—their gay and fitful flight—the splendor of their coloring and decorations, which present every variety of tint found in the different kingdoms of nature, distributed in markings and delineations of the most beautiful and diversified character, seem to confer on them a kind of superiority over other insects.

Butterflies are very numerous in species, although but a limited number inhabit this country. Between 2000 and 3000 have been described, and it is probable that no inconsiderable number yet remain undiscovered. About 75 different species are recorded as indigenous to Britain. A great proportion of the largest and most highly ornamented kinds are natives of the new world, especially of Brazil; but they abound in all tropical countries, and some of these exotics present the most sumptuous examples of insect beauty. Although our British butterflies can in no way compete with the magnificent examples just referred to, we yet possess many of great beauty, whether as regards the brilliancy of their color, or the harmonious manner in which these colors are distributed. The bluish-purple reflection that plays on the wings of the emperor of the woods, has a richness and brilliancy of tint, which is not often surpassed. The mode of painting employed to produce these rich tints, may not improperly be called a kind of natural mosaic, for the colors invariably reside in the scales, which form a dense covering over the whole surface. These scales are usually of an oval or elongated form, and truncated at the tip, where they are occasionally divided into teeth; but sometimes they are conical, linear, or triangular. They are fixed in the wing by means of a narrow pedicle, and are most commonly disposed in transverse rows, placed close together, and overlapping each other like the tiles of a roof. In some instances, they are placed without any regular order, and in certain cases there appear to be two layers of scales on both sides of the wings. When they are rubbed off, the wing is found to consist of an elastic membrane, thin and transparent, and marked with slightly indented lines, forming a kind of groove for the insertion of the scales. The latter are so minute that they appear to the naked eye like powder or dust, and as they are very closely placed, their numbers on a single insect are astonishingly great. Leeuwenhoek counted upwards of 100,000 on the wings of the silk moth, an insect not above one-fourth of the size of some of our native butterflies. But how much inferior must this number be to that necessary to form a covering to some foreign butterflies, the wings of which expand upwards of half a foot; or certain species of moths, some of which (such as the atlas moth of the east, or the great owl moth of Brazil,) sometimes measure nearly a foot across the wings. A modern mosaic picture may contain 870 tesserulæ, or separate pieces, in one square inch of surface; but the same extent of a butterfly's wing sometimes consists of no fewer than 100,736.

In common with several other extensive races of insects, butterflies derive their nourishment entirely from liquid substances, and the structure of the mouth is consequently very different from that of the masticating kinds. They are hence classed among the haustellated or suctorial tribes of insects. The most conspicuous and elaborately constructed organ, is the long flexible tube projecting from the mouth, which forms a canal through which the alimentary juices are absorbed. This instrument, which is sometimes of great length, is spirally convoluted when unemployed, but it can be unrolled with great rapidity, and is admirably fitted to explore the tubular corollas and deep-seated nectaries of flowers, for the purpose of extracting their sweet secretions. It is of a cartilaginous substance, and owes its great flexibility to its being composed of numerous rings or transverse fibres, bearing some resemblance to the annulose structure of earth-worms and some other animals. It is formed of two distinct pieces, which admit of being separated throughout their whole length. Each of these pieces is traversed longitudinally by a cylindrical tube, and being grooved on their inner side, they form when united another canal in the centre, of a somewhat square form, and wider than either of the two lateral ones. The junction of the two parts is so close that the inclosed tube is perfectly air-tight; and this union is effected by means of an infinite number of fillets, resembling the laminæ of a feather, which interlace and adhere to each other. Of these three tubes, the central one alone serves for the influx of the alimentary fluids, the two lateral ones being probably employed in transmitting air in aid of respiration, which, however, is mainly carried on by means of stigmata or lateral pores. The outer extremity of the proboscis is frequently beset with many membranous papillæ, resembling leaflets, which have been regarded by some authors as absorbents. From having observed them chiefly in long and slender trunks, Reaumur was led to conceive, that their only use is to render that organ more steady, by affording numerous points of support, and adhering in some degree to the substances into which it is inserted;—an explanation rendered highly probable by the fact, that the long and slender ovipositors of Ichneumons, and many other insects, are generally provided with some pointed projections near the tip, evidently intended for this purpose.

Both the different kinds of eyes which occur among insects are to be found in the butterflies. The ordinary, or compound eyes, are large and hemispherical, occupying greater part of the head, and no fewer than 17,325 lenses have been counted in one of them. As each of these crystalline lenses possesses all the properties of a perfect eye, some butterflies may therefore be said, if M. Puget's observations are correct, to have no fewer than 34,650. The stemmatic, or simple eyes, in the form of pellucid spots, are usually two in number, and placed on the crown of the head. They are probably often wanting, and, when present, are so indistinct, from being covered by the hairs and scales that clothe the surface, that their existence in any case among butterflies has been sometimes denied. The antennæ are of moderate length, and consist of a great number of joints, which usually increase in thickness towards the extremity, where they form a club or knob. They are greatly more uniform in appearance and structure than in the coleopterous or most other tribes, or in the nocturnal species of the same order, which often have them beautifully branched and plumose.

The thorax—that portion of the body intermediate between the head and abdomen—is composed of three segments, so closely united as apparently to form a single piece. Its most ordinary form approaches to cubical, any apparent deviation from that shape being chiefly caused by the greater length and density of the hairs and scales with which it is covered. Before the insertion of the upper wings, two corneous scales may be observed, covered with tufts of hairs, so as to make them resemble an epaulet: these have received the name of *patagia*, or tippets. The scutellum—a triangular piece in the hinder part of the thorax, which is very conspicuous in beetles and many other tribes—likewise exists in butterflies, but is very minute, and has its point directed forwards. The thorax is always shorter than the abdomen, and generally more robust, as it supports all the organs of motion, and contains the muscles by which the latter are actuated.

These important appendages are of course the wings and legs, of which it is necessary to give some account. The latter, as in all other genuine insects, are six in number, and composed of the same amount of pieces as in most of the class. They are inserted pretty close to each other, without any inequality in the size of the intervening spaces. The thigh is often fringed with long hairs, and the tibia is frequently armed with a spur near the middle, and two others at the tip. The tarsi in all the perfect legs are five-jointed, and furnished with two claws at the extremity, which are often bifid. Many of these insects, however, have the anterior pair of legs imperfect, or not adapted for walking, being too short to reach the plane of position, and usually drawn close to the sides of the thorax, the long hairs of which in a great measure conceal them from our view. These spurious legs have only one joint in the tarsus, which in some cases (as in *vanessa*, &c.) is without claws; and the species so circumstanced are named *tetrapod*, or four-footed butterflies.

The wings are of much greater extent, in proportion to the size of the body, than in any other tribe of insects. The forms which they assume are very various; but the most ordinary shape of the upper pair is triangular, with the apex of the triangle towards the body, while the outline of the under wings approaches to circular. They are traversed by numerous nervures, which give a great degree of strength to the wing, and hold in tension the thin elastic membrane of which it is composed. These nervures are tubular, and are permeated by an aërial and aqueous fluid, the action of which expands the wing when in a moist and corrugated state after the insect has emerged from the pupa. The principal branches rise from the point where the wing is attached to the body, and they divide towards the other extremity into numerous ramifications. The spaces into which the wing is divided by these nervures, are denominated areolets by Kirby and Spence; and these authors regard the upper wings as divisible into three larger longitudinal sections, which they term areas. The costal area occupies the anterior margin: the anal area, a narrow space along the posterior margin; and the intermediate area, all that part of the wing lying between the two others. The most conspicuous areolet in butterflies is towards the centre of the wing, at the base, and is usually closed on its outer side by transverse nervures. In many instances, however, there are no transverse nervures, and all the areolets are open towards the outer side.

With such an extent of "sail-broad vans," it is easy for butterflies to support themselves for a long time in the air; but their mode of flight, at least in Reaumur's opinion, is generally not very graceful. They seldom fly in a direct line, but advance by rising and falling alternately, in a succession of zigzags, up and down, and from side to side. By flying in this manner, they are supposed to elude more easily the pursuit of the smaller birds, which often make them a prey. "I one day watched with pleasure," says Reaumur, "a sparrow pursuing a butterfly on the wing for a considerable time, without succeeding in catching it. The flight of the bird was notwithstanding much more rapid than that of the butterfly, but the latter was always either above or below the point to which the bird directed its flight, and at which it expected to seize it." Many of the species, however, differ so much from each other in their mode of flying, that a practised eye can recognise them by this means alone. Such as are provided with strong wings, exercise a more steady and continuous flight, nearly resembling that of a bird, ascending high into the air, and often making their way against a pretty strong current of wind. Of our British species, the white admiral is the most celebrated for its manner of flying.

The hinder section of the body is the abdomen, which presents nothing peculiar in its form or structure. It consists of six or seven segments, and is attached to the posterior part of the thorax by a very small portion of its diameter. It is without any appendage at the extremity, there being nothing analogous to a sting or ovipositor among butterflies.

CHEMICAL COMPOSITION OF COLORS.

WHITES.	
White lead..........	Carbonate of lead.
London and Nottingham whites........	
Ceruse white........	
Flake white..........	
French white........	
Roman white........	
Zinc white..........	Oxide of zinc.
Tin white............	Ditto of tin.
Pearl white, false.....	Ditto of bismuth.
Ditto true.....	Pulverised pearls.
Constant white.......	Carbonate and sulphate of barytes.
White chalk.........	Ditto of lime.
YELLOWS.	
Naples Yellow.......	A compound of the oxides of lead and antimony.
Massicot............	Protoxide of lead.
Yellow Ochre........	Ditto of iron and earthy matter.
Oxford ditto.........	
Stone ditto..........	
Roman ditto.........	
Brown ditto..........	
Orpiment or King's yellow...........	Sulphuret of arsenic.
Madder yellow.......	From the root.
Gamboge............	Gum resin.
Indian yellow........	Uriophosphate of lime.
REDS.	
Vermillion	Bisulphuret of mercury.
Intense scarlet.......	Peroiodide of ditto.
Red lead............	Deutoxide of lead.
Red ochre...........	Peroxide of iron & earthy matter.
Dragon's blood.......	Gum resin.
Lakes..............	Brazil wood, gum lac, coccus.
Madders............	From the root.
Carmine............	From the coccus cacti.
BLUES.	
Ultramarine.........	Silica, alumina, sulphur and soda.
Cobalt blue.........	Vitrified oxide of cobalt, silica, and potass.
Smalt..............	
Royal blue..........	
Prussian ditto........	Ferrosesquicyanuret of peroxide of iron.
Antwerp ditto........	Ditto and alum.
Indigo ditto.........	From the leaves of the indigofera.
Intense ditto.........	
Blue verditer.	Carbonate of copper & lime
Mountain blue.......	Native carbonate of copper
Blue ochre..........	Subphosphate of iron and earthy matter.
ORANGE.	
Orange vermilion, or extract of.........	Bisulphuret of mercury & subsulphate of ditto.
Chrome orange	Bichromate of lead.
Orange lead..........	Mixture of proto- and deuto-oxides of lead.
Orpiment...........	Sulphuret of arsenic.
PURPLES.	
Cassius purple.......	Compound of the oxides of gold and tin.
Madder purple.......	From the root of rubia tintorum.
Carmine purple......	Carmine partially charred.
GREENS.	
Scheele's green......	Arsenite of copper.
Verdigris...........	Sub-acetate of ditto.
Mineral green........	Preparation from sulphate of copper.
Mountain ditto.......	Native carbonate of copper
Sap green...........	From the juice of buckthorn berries.
BROWN.	
Umber.............	Oxide of manganese of iron and earthy matter.
Vandyke brown......	Peat or bog earth.
Ivory brown.........	Bones partially charred.
Asphaltum..........	Mineral resin.
Mummy............	Ditto combined with animal matter.
Antwerp brown......	Asphaltum.
Bistre.............	Soot of wood fires.
Sepia..............	From the fish sepia (cuttle fish.)
Chesnut brown.......	From the horse chesnut.
Neutral tint.........	Compound of sepia, indigo, and madder.
BLACK.	
Ivory black..........	Bones charred to blackness
Lamp black.........	Soot of resinous wood.
Frankfort black......	From the calcined lees of wine.
Blue black..........	Charcoal.
Spanish black........	Charcoal from cork.
Indian ink..........	Lamp black, &c.
Black lead..........	Native carburet of iron.

DURATION OF MACHINERY.

THE time during which a machine will continue to perform its work effectually, will depend chiefly upon the perfection with which it was originally constructed,—upon the care taken to keep it in proper repair, particularly to correct every shake or looseness in the axes,—and upon the smallness of the mass and of the velocity of its moving parts. Every thing approaching to a blow, all sudden change of direction, is injurious. Engines for producing power, such as wind-mills, water-mills, and steam-engines, usually last a long time. But machinery for producing any commodity in great demand, seldom actually wears out; new improvements, by which the same operations can be executed either more quickly or better, generally superseding it long before that period arrives: indeed, to make such an improved machine profitable, it is usually reckoned that in five years it ought to have paid itself, and in ten to be superseded by a better

"A cotton manufacturer," says one of the witnesses before a committee of the House of Commons, "who left Manchester seven years ago, would be driven out of the market by the men who are now living in it, provided his knowledge had not kept pace with those who have been, during that time, constantly profiting by the progressive improvements that have taken place in that period."

The effect of improvements in machinery, seems incidentally to increase production, through a cause which may be thus explained. A manufacturer making the usual profit upon his capital, invested in looms or other machines in perfect condition, the market price of making each of which is a hundred pounds, invents some improvement. But this is of such a nature, that it cannot be adapted to his present engines. He finds upon calculation, that at the rate at which he can dispose of his manufactured produce, each new engine would repay the cost of its making, together with the ordinary profit of capital, in three years: he also concludes from his experience of the trade, that the improvement he is about to make, will not be generally adopted by other manufacturers before that time. On these considerations, it is clearly his interest to sell his present engines, even at half-price, and construct new ones on the improved principle. But the purchaser who gives only fifty pounds for the old engines, has not so large a fixed capital invested in his factory, as the person from whom he purchased them; and as he produces the same quantity of the manufactured article, his profits will be larger. Hence, the price of the commodity will fall, not only in consequence of the cheaper production by the new machines, but also by the more profitable working of the old, thus purchased at a reduced price. This change, however, can be only transient; for a time will arrive when the old machinery, although in good repair, must become worthless. The improvement which took place not long ago in frames for making patent net was so great, that a machine, in good repair, which had cost 1200*l.*, sold a few years after for 60*l.* During the great speculations in that trade, the improvements succeeded each other so rapidly, that machines which had never been finished were abandoned in the hands of their makers, because new improvements had superseded their utility.

The durability of watches, when well made, is very remarkable. One was produced, in *going order*, before a committee of the House of Commons to inquire into the watch trade, which was made in the year 1660; and there are many of ancient date, in the possession of the Clock-maker's Company, which are still *actually kept going*. The number of watches manufactured for home consumption was, in the year 1798, about 50,000 annually.

Machines are, in some trades, let out to hire, and a certain sum is paid for their use, in the manner of rent. This is the case amongst the frame-work knitters: and Mr. Henson, in speaking of the rate of payment for the use of their frames, states, that the proprietor receives such a rent that, besides paying the full interest for his capital, he clears the value of his frame in nine years. When the rapidity with which improvements succeed each other is considered, this rent does not appear exorbitant. Some of these frames have been worked for thirteen years with little or no repair. But circumstances occasionally arise which throw them out of employment, either temporarily or permanently. Some years since, an article was introduced called "*cut-up work*," by which the price of stocking frames was greatly deteriorated. From the evidence of Mr. J. Rawson, it appears that, in consequence of this change in the nature of the work, *each frame could do the work of two*, and many stocking frames were thrown out of employment, and their value reduced.

This information is of great importance, if the numbers here given are nearly correct, and if no other causes intervened to diminish the price of frames; for it shows the numerical connexion between the increased production of those machines and their diminished value.

The great importance of simplifying all transactions between masters and workmen, and of dispassionately discussing with the latter the influence of any proposed regulations connected with their trade, is well exemplified by a mistake into which both parties unintentionally fell, and which was productive of very great misery in the lace trade. Its history is so well told by William Allen, a frame-work knitter, who was a party to it, that an extract from his evidence, as given before the Frame-work Knitters' Committee of 1812, will best explain it.

"I beg to say a few words respecting the frame-rent; the rent paid for lace-frames, until the year 1835, was 1*s.* 6*d.* a frame per week; there then was not any very great inducement for persons to buy frames and let them out by the hire, who did not belong to the trade; at that time an attempt was made, by one or two houses, to reduce the prices paid to the workmen, in consequence of a dispute between these two houses and another great house: some little difference being paid in the price among the respective houses, I was one chosen by the workmen to try if we could not remedy the impending evil: we consulted the respective parties, and found them inflexible; these two houses that were about to reduce the prices, said that they would either immediately reduce the price of making net, or they would increase the frame-rent: the difference to the workmen was considerable, between the one and the other; they would suffer less, in the immediate operation of the thing, by having the rent advanced, than the price of making net reduced. They chose at that time, as they thought, the lesser evil, but it has turned out to be otherwise; for, immediately as the rent was raised upon the per centage laid out in frames, it induced almost every person, who had got a little money, to lay it out in the purchase of frames; these frames were placed in the hands of men who could get work for them at the warehouses; they were generally constrained to pay an enormous rent, and then they were compelled, most likely, to buy of the persons that let them the frames, their butcher's meat, their grocery, or their clothing: the encumbrance of these frames became entailed upon them: If any deadness took place in the work they must take it at a very reduced price, for fear of the consequences that would fall upon them from the person who bought the frame: thus the evil has been daily increasing, till, in conjunction with the other evils crept into the trade, they have almost crushed it to atoms."

The evil of not assigning fairly to each tool, or each article produced, its *proportionate value*, or even of not having a perfectly distinct, simple, and definite *agreement* between a master and his workmen, is very considerable. Workmen find it difficult in such cases to know the probable produce of their labor; and both parties are often led to adopt arrangements, which, had they been well examined, would have been rejected as equally at variance in the results with the true interests of both.

At Birmingham, stamps and dies, and presses for a great variety of articles, are let out: they are generally made by men possessing small capital, and are rented by workmen. Power also is rented at the same place. Steam engines are erected in large buildings containing a variety of rooms, in which each person may hire one, two, or any other amount of horse power, as his occupation may require. If any mode could be discovered of transmitting power, without much loss from friction, to considerable distances, and at the same time of registering the quantity made use of at any particular point, a considerable change would probably take place in many parts of the present system of manufacturing. A few central engines to produce power might then be erected in our great towns, and each workman, hiring a quantity of power sufficient for his purpose, might have it conveyed into his own house; and thus a transition might in some instances be effected, if it should be found more profitable, back again from the system of great factories to that of domestic manufacture.

The transmission of water through a series of pipes might be employed for the distribution of power, but the friction would consume a considerable portion. Another method has been employed in some instances, and is practised at the Mint. It consists in exhausting the air from a large vessel by means of a steam engine. This vessel is connected by pipes, with a small piston which drives each coining press; and on opening a valve, the pressure of the external air forces in the piston. This air is then admitted to the general reservoir, and pumped out by the engine. The condensation of air might be employed for the same purpose; but it must be admitted, that there are some unexplained facts relative to elastic fluids, which require further observations and experiment before it can be used for the conveyance of power to any considerable distance. It has been found, for instance, in attempting to blow a furnace by means of a powerful water-wheel driving air through a cast-iron pipe of above a mile in length, that scarcely any sensible effect was produced at the opposite extremity. In one instance, some accidental obstruction being suspected, a cat put in at one end found its way out without injury at the other, thus proving that the phenomenon did not depend on interruption within the pipe.

The most portable form in which power can be condensed is, perhaps, by the liquefaction of the gases. It is known that, under considerable pressure, several of these become liquid at ordinary temperatures; carbonic acid, for example, being reduced to a liquid state by a pressure of sixty atmospheres. One of the advantages attending the use of these fluids, would be that the pressure exerted by them would remain constant until the last drop of liquid had assumed the form of gas. If either of the elements of common air should be found to be capable of reduction to a liquid state before it unites into a corrosive fluid with the other ingredient, then we shall possess a ready means of conveying power in any quantity and to any distance. Hydrogen probably will require the strongest compressing force to render it liquid, and may, therefore, possibly be applied where still greater condensation of power is wanted. In all these cases the condensed gases may be looked upon as springs of enormous force, which have been wound up by the exertion of power, and which will deliver the whole of it back again when required. These springs of nature differ in some respects from the steel springs formed by our art; for in the compression of the natural springs a vast quantity of latent heat is forced out, and in their return to the state of gas an equal quantity is absorbed. May not this very property be employed with advantage in their application.

Part of the mechanical difficulty to be overcome in constructing apparatus connected with liquefied gases, will consist in the structure of the valves and packing necessary to retain the fluids under the great pressure to which they must be submitted. The effect of heat on these gases has not yet been sufficiently tried, to lead us to any very precise notions of the additional power which its application to them will supply.

The elasticity of air is sometimes employed as a spring, instead of steel: in one of the large printing-presses in London, the momentum of a considerable mass of matter is destroyed by making it condense the air included in a cylinder, by means of a piston against which it impinges.

The effect of competition in cheapening articles of manufacture sometimes operates in rendering them less durable. When such articles are conveyed to a distance for consumption, if they are broken, it often happens, from the price of labour being higher where they are used than where they were made, that it is more expensive to mend the old article, than to purchase a new. Such is usually the case, in great cities, with some of the commoner locks, with hinges, and with a variety of articles of hardware.

LINE ENGRAVING.

The subject having been forwarded by means of etching, (as we have already described,) the process is completed by engraving. This is executed by an instrument called a *graver*, which is either square or lozenge, according to the work for which it is to be used. In the operation of cutting the lines with a graver, there is a roughness, or burr, thrown up, which must be removed by the scraper. Lines in an historical piece or portrait are not cut to their depth or thickness at once, but are produced by being frequently re-entered with the graver. This not only gives clearness, but also depth of tone, and regularity of line. The first cutting of lines with the graver is termed laying in the shadows; all the effect being produced by the finishing. To facilitate the progress of the work, where depth of tone is required, those parts are subjected to the operation of re-biting; by which means, in the course of an hour to two, an effect may be given to the work, which would have taken some weeks by the more tedious use of the graver. To see the state of the engraving without an impression, an oil rubber, with black in it, is used, with which the lines are filled up; and a pretty good idea of the effect may be ascertained. The more delicate parts of an engraving are generally done in *dry point*, that is, by means of the etching needle pressed into the copper, so as to produce the depth of line required, and the burr afterwards scraped off.

If the engraver makes a mistake, or changes his mind, respecting any part of his work, this can be remedied by scraping it out, or concealing it by burnishing it firmly; and, if not too deep, it can be polished with charcoal and water, and afterwards rendered more smooth with the burnisher. But if the part taken out is strong, it will, in all probability, be below the surface of the plate. In which case it must be *struck up*; by marking the exact size and situation of the hollow, on the back of the plate, by a pair of callipers, and placing the face of the plate, on a finely polished steel anvil, beat it up with a small hammer, to the level, from behind.

In the process of engraving, a shade of tissue paper is used, to prevent the reflection of light from the copper into the eyes. This is made by pasting paper on a hollow stretching frame, which is placed with its base near the till of the window, while the top part projects obliquely into the room. This is, however, quite unnecessary in etching. An experienced eye can, at once, detect which lines have been etched, and which have been produced by the graver. The former are always more or less serrated on their edges, while the latter are clear and smooth. Most engravers use a glass, both in etching and finishing their plates.

Engraving in Outline.—This method is well adapted for the representation of gems and statuary, where a likeness of an object is to be given, and where it is desirable to avoid the expense of a finished engraving. As a substitute for shadows, a stronger line is cut, which also takes off from the tameness of a uniformly thick line. Outline may either be executed by first etching the subject, and cutting the stronger lines with the graver; or it may be done by transferring the subject to the copper by means of a wax ground, and the outline scratched with the point, as in writing, and then cut with the graver.

Stippling.—This is engraving in dots in place of lines. There are two ways of executing this species of engraving. The first is by pursuing the same process as in an etching, and having the subject transferred to the plate. The outline and part of the shading is executed with an etching point, and then bit, as described in etching. When the ground is removed, the engraving is completed with the graver. The dots produced by the point are necessarily round, while those made by the graver are somewhat rhomboidal, or slightly triangular, depending on the kind of graver which is used. If engravings of this kind are examined by means of a lens, it will be found that what appears a single dot to the naked eye, consists of a number of very minute dots. This gives to the engraving that beautiful softness which is observable in the works of Ryland, Freeman, and other first-rate stipple engravers. This kind of engraving is more tedious in its execution than line engraving, and hence more expensive. Stippling has much softness and resembles a drawing; indeed, when printed in colors, engravings of this kind very closely resemble colored drawings.

In the coarser kinds of work, an instrument has been devised for producing dots in a more expeditious manner than by the point or graver. This is called a *roulette*, a kind of toothed wheel, resembling a spur, moving on a pivot, but with from three to six or eight rows of points; so that by running this along the face of the plate, a large surface or shadow can be produced in a very short time. This is, however, quite inapplicable to the finer kinds of work, as the mechanical regularity of the dots cannot be concealed without much labour.

ELECTRO-GILDING.

(*To the Editor.*)

Sir,—Seeing amongst your Answers to Correspondents in your last Part, that you seemed to have failed in the electro-gilding, I have sent you these few lines, which, if you think them worthy your pages, you would perhaps insert.

The manner in which I succeeded was this, viz:—I took six ½-lb. pots of Mr. Grove's battery, in not *very great activity*, placed the auro-cyanide of potassium, (which I obtained from Dymond's, High Holborn,) in a glass or earthenware vessel, with the article to be gilt immersed in it, connected with the zincode; to the wire from the platinode I wound a piece of platinum wire, *as fine as a hair*, and immerse it the smallest possible degree into the solution, just above the surface of the article to be gilt, and the gold will be beautifully thrown down in its metallic state. The gold thrown down is very much paler than the gold produced by the water gilding. It is very essential that the surface of the article to be gilt is chemically clean; washing the article in boiling sulphuric acid is generally sufficient.

The salt spoon inclosed has been gilt by the above process about a year and a half, and has been in constant use ever since. The silver palate plates of dentists which I have gilt in this way have stood very well, the silver not being acted upon by the saliva, as in the plates done by the water gilding.

JOHN BOCKETT.

1, *Everett Street, Russell Square.*

I should think any other galvanic battery would answer as well as Grove's, but as to that one I speak from proof.

[The salt spoon alluded to, and which we have sent back by post, shows that the above is attended with great success.—ED.]

MEMORANDA.

The great difficulty in improving telescopes has been the manufacture of flint-glass lenses of sufficient size. Fraunhofer made one for Dornart 9.5 inches diameter, and 14 feet focal length. It magnifies from 175 to 700 times. But Sir James South has one of 12 inches diameter, and 20-feet focal length, in his observatory at Kensington. To obviate this difficulty, Mr. Barlow has made an instrument with a plate-glass object-glass, and corrected the colors, by interposing a lens filled with sulphuret of carbon, whose refraction is that of flint glass, while it is perfectly transparent. The second lens, of course, enlarges the angle, and increases the magnifying power. A 7·66 feet instrument, therefore, magnifies 700 times, but with less light than Sir James South. Rogers has proposed to interpose flint-glass of smaller size. Sir J.W. Herschel has a reflector of 20-feet, with which he sees comets that no other telescope in Europe can render visible.

Dolland's discovery of the achromatic lens of crown-glass and flint-glass was not accidental; but the result of a long series of experiments begun with a view to sustain Newton's error about equal refrangibility and dispersion, which had been disputed by Euler. It was an English manufacture till the French began also to make flint-glass.

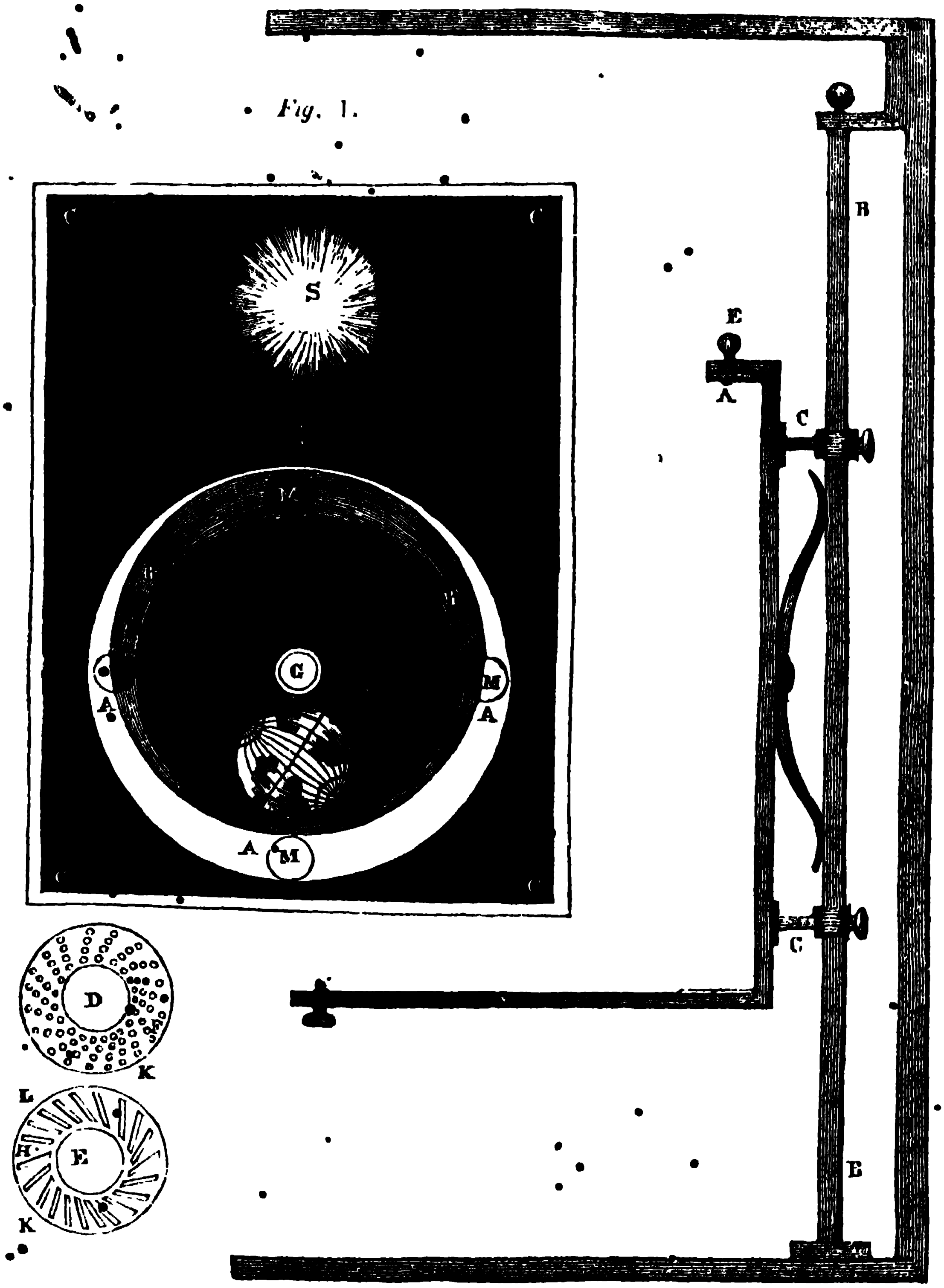
As the size of every object is the angle which its diameter subtends, so the true power of a microscope is the increase of that line; but, to augment the wonder, many square the line for the superfices, and others cube it for the solid. Thus a power of 20 is often called 400 or 8000.

A plano-convex lens has the greatest field of view; double and equal convex the least; the side of least convexity should be nearest.

The sound of a bell dies away as the exhaustion by an air-pump proceeds; but sound continues, since the exhaustion cannot be perfect.

A bell not only does not sound in an exhausted receiver, but if in a receiver not exhausted covered by another, and the intervening space exhausted, that void space will not conduct the sound.

Fig. 1.



2.

- GOOCH'S MACHINE FOR ASTRONOMICAL ILLUSTRATIONS.

GOOCH'S MACHINE FOR ASTRONOMICAL ILLUSTRATIONS.

(To the Editor.)

SIR,—Observing in page 297, vol. 1, a beautiful display of fireworks, amongst which, the art of *sun-making*, I take the liberty to show you my plan of *sun* and *moon* making. I have now by me a machine or frame which fits into a box, where lights are contained, which beautifully represents the *sun* in full splendor, together with the earth and moon revolving round the centre of gravity.

C C C C, is the frame which contains the apparatus with a hole or aperture cut out: and at the back of this aperture is placed a moveable plate of pasteboard or card-paper A A A; in it are cut the four holes for the moon M M M, and also the circle that represents the *earth*; over these holes is stretched some fine silk, or transparent paper. The whole of this turns freely on the pin or centre of gravity G, and to which pin is also placed a pully, to put the same in motion by other connected pullies. Fixed in the frame B B B, is a zinc or tin plate fixed to the back of the frame, in the form as represented in the drawing; so as to hide the light of the moon to form the different phases, as she moves round the centre of gravity; consequently, to give the appearance of full moon, new moon, and all the other phases, as she revolves according to her situation to the sun with the earth. I have also placed the sun, as you see, in the same frame. It is constructed thus:—K and K L, are tin cylinders, made to fit on each other, and move freely, by the connected machinery, pullies or wheel-work. At the back of each cylinder, as at D and E, is a lamp placed, and the front of the aperture of E is covered with silk or paper; the front of these cylinders is made of zinc, F and H are concave; D is the outermost, both are perforated, one with slits and the other with holes, in opposite oblique directions, so that when the machine is put in motion, it has a beautiful appearance like the sun's rays diverging from the outer portion of the disk in oblique rays, or tangents.

Fig. 2, is the slide holder, and which may be used with any apparatus of this description, either for entertaining purposes or for astronomical illustrations. A A A is an iron frame, and in which the frames or views are to be placed; at A A are small projecting pieces which fit into a groove in the picture frame, and are fastened by two screws C C, to hold it steady. B B, is a brass upright rod, on which C C slide and carry the frame, which is kept steady by a spring D; this will be found exceedingly convenient to exhibit the different views.

Norwich B. GOOCH.

BLACK-LEAD-PENCIL DRAWINGS.

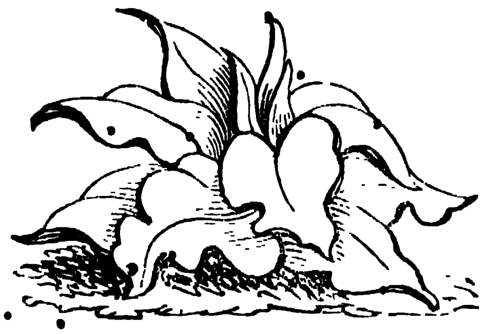
THESE drawings have their admirers; they can be finished up to considerable neatness, or to powerful effect; and therefore a few hints respecting such use of the lead pencil are subjoined. The pencil should be of the best Cumberland lead, and it should not be cut to a point, after the first time, until the exhaustion of the lead renders it absolutely necessary. The blunted pencil, by being *waved* upon a form, is capable of giving to it any degree of shade. The term *waved* is not explanatory: the process is, passing the pencil backwards and forwards in zigzags of convenient length, in such manner as not to repeat one marking on another, but so close as to produce an equality of tone over the space required. This uniform tone is called the *grain*; and by judicious waving, in different directions, any gradation of strength may be communicated. The point of the pencil is destructive to the effect alluded to, because it will give a line which repetitions only render more offensive.

The clearness of this grain produced on masses which have been previously drawn with a tender outline, is essential to the preservation of distances by gradations of power. It is the perfection of this kind of drawing to effect as much as possible independently of outline, or the evidence of it in the process of waving in the masses. Thus, the most remote parts may be waved in, as if there were so little light on them that they would be indistinctly seen—the second plan waved in as if a greater degree of light, or rather distinctness, were cast upon it, the objects being more defined and proportionally stronger than the distance—the foreground waved in with the greatest degree of light cast on it, so as to render every part evident, by power and characteristic touch.

In examining a natural scene, it may be observed that all is void of outline, and that every distinct object is relieved from that which adjoins it, by a separation of light, shade, or other accidental peculiarity. In sketching, nevertheless, outline is adopted, because it is the only means of obtaining a knowledge of the forms, and the simplest means of detaching them: but immediately after the student shall have become acquainted with the form of an object, it must be considered as having been operated upon by light, and the portion of outline which is next the source of illumination, should be more tenderly defined than those parts which may be differently situated. Now, this attention to light and shade in outline is preparatory to the more correct representation of nature, and the student ought to be satisfied, that, in whatever may be attempted, time will not be lost in the endeavour to preserve the proper lights and shades. At first, these undertakings should be of the simplest kind; there is no production of bountiful nature that is not worthy of consideration, or that is incapable of yielding its reward to the attentive student. Suppose it to be the leaf of a willow, the elongated curve, with its smooth edges, and tapering vein down the centre, offer practice for command of hand in conveying the imitative lines to the paper, while a perfect knowledge of the character of the leaf is at the same time acquired. It is impossible thus to appeal to original nature, without obtaining valuable information.

The leaf of the elm, with its contracted curve, serrated edges, and many veins, offers subjects for practice and closer inspection of form. The oak, with its longer leaf and waving edges, presents to the investigating mind a great variety of form and character; but these leaves present themselves in many peculiar forms, that give an increased interest to the lines that may describe them. They are to be seen curved in a picturesque manner, twisted in fantastic shapes, and clustered beautifully. Let the student select from any tree a small sprig, having three or four leaves, and place it naturally in front of the drawing board, as an object for study. Then attentively examine the position of each leaf, its graceful connection with the stem, and the insertion of the leaf-stalk into the wood. Such a tranquil investigation of the distinct parts of which the object is composed, has been observed to lessen a confusion of ideas that takes possession of a juvenile student, when as a whole it has been contemplated, or rather glanced at, with a fear of not being able to imitate what was seen. Why fear? why delay? has been asked. Not knowing where to begin, or not perceiving how to separate the parts, has been the answer. This was not deficiency in power of mind, but a seeming reluctance to call it forth. Nothing can be done while the eye is roving over the object; no beginning, no end appears. Let the mind be brought to act upon what is required; direct the attention to that part which may be deemed the principal, or the most conspicuous leaf upon the sprig; consider its position; observe if it project to the front, or laterally; what portion of the upper surface is seen; and if so, how it is curled to display any part of the under surface. When all that relates to the principal leaf has been thought upon, the part on which to commence is suggested to the mind, and the hand imitates that to which the eye is studiously directed.

The first leaf being lightly sketched, it is easy to add an adjoining leaf, and so on till all be on the paper. The student should then coolly criticise his work, looking over every part, to detect any deviation from the forms of the original. If this examination and correction produce likeness, let the lines and characteristic marks be drawn in with a firmer or bolder pencil; very often the most trifling touch in addition will communicate what seemed to be required to give character to a leaf. A weaker line on the side which meets the light, and the stronger line confined to those parts which may be opposed to the light, materially assist in giving satisfaction, from the spirit which such sketching imparts. The student is at all times advised to be sparing in the use of Indian rubber; at times it is useful; but generally it is brought into action, because thought had not previously been sufficiently employed.



The above figure may serve to convey an idea of what is intended by the preceding remarks. The light is from the right, on which the tenderest lines are preserved, while those opposed to the light receive a more powerful marking, with occasional increase of force. Such studies as these should be made in the fields, where there is not a hedge-row but presents numberless subjects, each with its form and characteristic touch—the plantain, the dock, and the thistle; the fern, the briar, and the thorn. The advantages to be derived from consulting these objects where they grow, must be obvious to every one who will admit that originals are superior to copies, which all prints and drawings are. The student can as easily copy from nature as from an imitation of nature; in the one instance the sketches are such as were dictated by love of the art, and so far are originals; in the other case, however closely the sketches may have been imitated, they are mere servile copies of what another thought to be representations of nature. The only method by which to produce a satisfaction that stimulates to exertion in drawing, is to study and copy carefully the characteristic forms of objects as nature presents them. Let the student be provided with two sketch-books, one for scenery, and the other for smaller studies, called "*bits*." That which is shut may serve as a seat for the draughtsman, while he has his pencil at work upon the other. In sketching a plant, first observe if the outline be smooth or rough; how the leaves project, recede, point vertically, or recline on each other. Endeavour to arrive at a comprehensive notion of the work that is to be done, including a perception of what is very appropriately called the feeling of the subject. Then commence by sketching the form of the principal or most conspicuous leaf with a tender line, and correct it, if required, without rubbing out, until the general form of the leaf shall appear amid the slightly sketched lines; this the mind will seize upon, in consequence of the likeness being perceived; then let this line be put in with a little more power, and with a handkerchief brush away the first trials. The leading feature of the plant being thus laid down, the rest, which are necessarily of the same character, will be easily executed, care being taken to observe from what part a second leaf may issue. Be attentive to the commencing line of each leaf, and proceed as with the first, till the whole group be sketched in. Do not neglect any part, nor conclude that enough has been sketched of a subject so simple, nor think that at another time it may be more carefully attended to; these are the causes of failure; no time is like the present; endeavour to obtain a correct outline, at the risk of being considered very slow. Let the object be well sketched, and rapidity will soon be acquired. When the character shall have been fixed, the detail will go smoothly on; the knowledge of the plant, with its peculiarities of growth, and its natural appearance, will never depart from the memory. With respect to indications of light and shade and touch, the soft pencil may be pressed with power on the shade-edge of the leaves, with occasional repetitions, or the thickness of touch may be doubled; to indicate curves, or the curled edges of leaves. At all times give a boldness of line with a pencil rather soft, because it can be used with more freedom, and will communicate more spirit, than a hard or fine-pointed pencil. The lines of which a sketch may be composed, will appear fine or coarse, more by a comparison between the strength of the lines on its light and on its shade lines, or touch, than by reference to ordinary thinness or delicacy of line. This is mentioned to induce a boldness of outline in whatever may be attempted from nature, since it admits of freedom in execution, and expression of character which can be recognised, while the efforts with a fine-pointed pencil produce a meagre and spiritless effect.

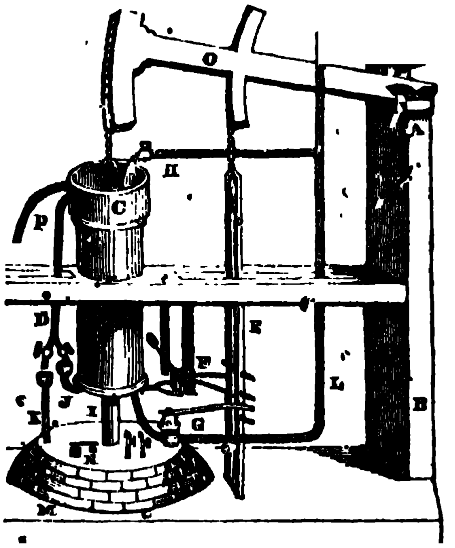
The figure annexed is a combination of rural objects that may frequently be observed on the road-sides. These are simple subjects, but they possess character, and such as artists avail themselves of as accessories in landscape painting. Every production of nature has its value; the smooth edges of the coarse grass, as the blades curve in various directions, are worthy of the attention of the student, presenting a variety of sweeps and accidental forms that will assist in giving freedom to the use of the pencil. The same tuft of grass will furnish enough for several studies; on the different sides new combinations become visible, and each with its share of interest. On such subjects select the blades of grass which are most prominent, let the character be clearly defined, and let those curves which project be distinguished from those which recede or fall sideways; without this, the whole will be a mass of confusion, which no after-corrections can render clear. These may appear tedious to the ambitious student, but they teach how essential patience is to the obtaining of a correct sketch. It is by searching for the various beauties, and carefully copying them into the sketch-book, that the characters can be appreciated; and it is by reference to those judiciously selected transcripts from nature, that the remembrance of their peculiarities is preserved.

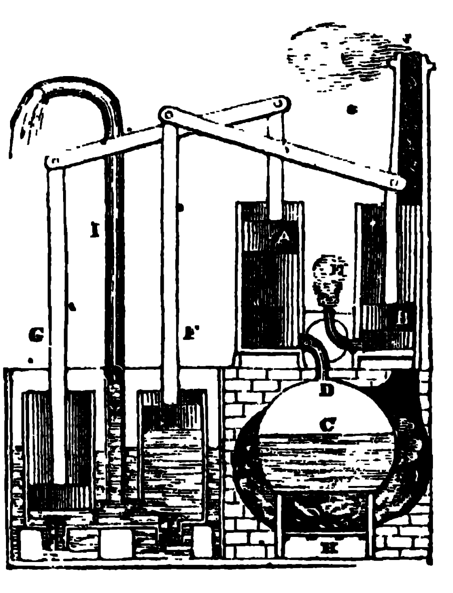
STEAM AND THE STEAM ENGINE,

(Resumed from page 373.)

SCARCELY had the atmospheric engine of Newcomen been invented, than mechanicians began to contrive to do away with the inconveniences arising from the necessary employment of boys to open and close the cocks admitting the steam, and condensing water. From the imperfect attention which even an assiduous attendant could give to the management of these valves, the performance of these engines was very irregular, and the waste of fuel very great, until a boy, named Humphrey Potter, contrived means of making the engine work its own valves. This contrivance, though made with no other design than the indulgence of an idle disposition, nevertheless constituted a most important step in the progressive improvement of the steam engine, for by its means, not only the irregularity arising from the negligence of attendants was avoided, but the speed of the engine was doubled. Potter attached strings to the levers which worked the valves, and carrying these strings to the working beam, fastened them upon it in such a manner that as the beam ascended and descended, it pulled the strings so as to open and close the proper valves with the most perfect regularity and certainty. This contrivance was afterwards much improved by an engineer, named Beighton, who attached to the working beam a straight beam, called a *plug frame*, carrying pins, which in the ascent and descent of the beam struck the levers attached to the valves, and opened and closed them exactly at the proper moment. The engine thus improved, required no other attendance except to supply the boiler occasionally with water, and to attend to the furnace. The improvements upon the atmospheric engine invented by Beighton, will be understood by the following cut.

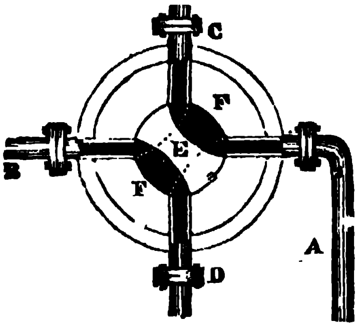
In explaining this engine, it is not necessary to explain the mode of action of the steam, it being the same as in the last-described engine. The various parts will be easily understood. A B being a support for the axis of the working beam. C, the steam cylinder. D, a pipe to carry off waste water from the top of the piston; the water being admitted there by the pipe. H, is intended to keep the piston steam tight. E, the plug frame, F and G, the Y *piece*, that is, a lever in the shape of the letter Y, which meets the *tappets* on the plug frame. I, the steam pipe. J, the *snifting* valve, which is a small valve opening upwards, and communicating with the bottom of the cylinder; its use is to suffer the air in the cylinder to escape at its first working, and afterwards whenever the air accumulates. K, a pipe for the supply of the boiler. L, pipe conveying the condensing water. M, the boiler. N, the safety valve. The inventions which took place after this period, and even until the time of the celebrated Watt, seem to be rather endeavours to improve the engine of Savory, than this atmospheric engine of Newcomen; thus, Desaguliers, Gensanne, Blakey, François, Nuncarrow, and others, employed their talents, and although their engines, and some rotatory engines invented about the same period are interesting, from the ingenuity bestowed upon them, yet, as we are anxious to conclude this already too extended article in one paper more, which will be devoted to the improvements of Mr. Watt, we are obliged to pass them all by till a future opportunity. It would be unpardonable, however, to omit in this account, the notice of the first high pressure engine, which is that of Mr. Leupold, and the first locomotive, that of Messrs. Trevethick and Vivian. Leupold's engine is seen below, taken from a drawing given by himself.





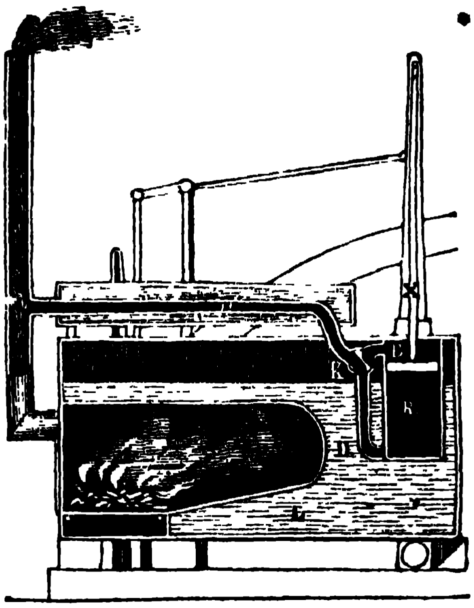
The boiler C, communicates by a cock D, with the bottom of two cylinders, having pistons A, B, moving in them; these pistons are attached to the levers by the piston rods. To the other end of these levers are fixed pump-rods F, G, having pistons at their lower ends working into the barrels or cylinders; I, an eduction-pipe, communicating with the pump, in which the water is forced upwards; H, the fire-place; D, a cock, so constructed as to shut off the communication between the boiler and either of the cylinders, while it opens a communication with the atmosphere.

In the situation of the apparatus shown in the figure, the steam in the boiler flows by the passage in the cock, into the cylinder A, and presses the piston upwards; this depresses the pump-rod G, fixed to the other end of the lever, which forces the water (under the plunger) up the pipe I. When the steam has raised the piston A, to nearly the top of the cylinder, the cock D is turned, and the passage between the cylinder A and the boiler is closed, and a communication is opened from the inside of the cylinder into the atmosphere. The weight of the rod and piston A, being made greater than G, the piston A falls to the bottom of the cylinder, and the steam which raised it escapes into the atmosphere. From the construction of the fourway-cock, at the moment in which the passage of steam into the cylinder A was closed, another passage was opened between the boiler and the cylinder B; the elasticity of the steam forces the piston B upwards, and depresses the plunger at the end of the rod F, and impels the water in the barrel under it, up the pipe L. When the piston B has reached the top of its cylinder, or made its stroke, the further passage of steam from the boiler is shut off by turning the cock D; and the steam escapes into the atmosphere; and B, descends in the cylinder by its preponderance in the same manner as C. During the ascent of B, A has fallen to the bottom of its cylinder. The steam-passage from the boiler being then opened, A is again raised in its cylinder while the vapour in B is escaping into the atmosphere; thus producing an alternate vertical motion in the pump-rods F and G. It was subsequently suggested to attach the levers to each other, by which the ascent of one piston depressed the other without employing a counterpoise.



The project of Dr. Robison in 1759, to apply the steam engine to move carriages, was accomplished in 1802 by Messrs. Vivian and Trevithick; and in carrying the speculation into practice, they produced a steam engine of pre-eminent merit and ingenuity. The *principle* of moving a piston by the elasticity of steam against the pressure only of the atmosphere, was described by Leupold, but in his apparatus it acted only on one side of the piston. In Trevithick and Vivian's engine, the piston is not only raised but depressed by the elasticity of the steam; and although other modes of admitting the vapour may be employed, they gave the preference to Leupold's fourway-cock.

Trevithick's engine is compact and simple in its operation. Steam is admitted from the boiler under a piston moving in a cylinder, which impels it upward; when it has reached this limit, the communication between the boiler and under-side of the piston is shut off, and the steam which has raised the piston is allowed to escape into the atmosphere; a passage is opened between the boiler and the upper side of the piston, which is then pressed downwards: and the steam is again allowed to escape into the atmosphere. From this it is obvious that its power will be equal to the difference between the pressure of the atmosphere and the elasticity of the steam. The figure below will explain the operation of Trevithick and Vivian's apparatus; the parts are, however, to be considered, as placed to explain their operation in the clearest manner, rather than in the situation in which they are usually fixed in practice. R is the steam cylinder; B the piston; and X its rod. The pipe D connects the top and bottom; H conveys the steam after it has moved the piston into the chimney. K a fourway-cock, which is moved by a lever acted on by the rise and fall of the piston-rod; L the boiler, in which the cylinder is placed, and the fire-place made within it, as in some other engines.



If the steam above the water is of sufficient temperature, the cock is turned in the position shown in the figure. A communication, it will be apparent, is now open between the upper side of the steam piston and the steam in the boiler, and between the under side of the steam piston and the chimney, or the atmosphere. The steam, however, is capable of a temperature considerably above that required merely to balance the piston, or about fourteen and a half pounds to each square inch; it would, as used in these engines, generally balance four or five times that weight; and of course the piston is impelled downwards in the cylinder. When it has made its stroke, the cock is turned by the lever or pin attached to the working-beam, or horizontal arm, into the opposite position. This opens a communication between the under side of the piston and the boiler, and between the upper side and the chimney. The preponderance of the pressures is

now beneath the piston, and it is forced upwards; while the steam in the upper part of the cylinder escapes into the chimney, and thus alternately. The steam, after it leaves the cylinder, is conducted through the pipe O, into the chimney. This pipe is inclosed in another, containing the water which is to supply the boiler by a small force pump; and from passing along this pipe it is injected into the boiler at a high temperature, which saves so much of the heat that would otherwise escape into the atmosphere and be lost. The reciprocating motion may be converted into a rotatory one by a crank, and the motion equalized by the intermediate mechanism of a fly.

(*To be continued.*)

THE APOLLONICON.

This musical machine, which is constructed on the principle of the organ, by a peculiar modification of the pipes, produces an excellent imitation of the tones of all the most admired wind instruments; the combined effect of the whole being similar to that of a numerous and well-chosen orchestra. This magnificent contrivance, unrivalled in this or any other country, is the invention of Messrs. Flight and Robson, who spent five years in its completion; and as a popular description of it cannot fail to be acceptable to the amateurs both of musical and mechanical science, we propose to give such an account of the instrument as may serve to convey a general idea of its construction. In the apollonicon, as in the organ, the sound is produced by a current of air, urged by bellows, through several series of vertical pipes. In the apollonicon there are two pairs of bellows, placed below the floor of the apartment in which the instrument stands; the wind from which passes through a reservoir and a tube, called a wind trunk, into an air-tight compartment, called a wind chest. The pipes which, by various modifications of their construction, produce the sounds of the different instruments, are ranged in rows one behind the other, parallel to the front of the machine, in the order of the gamut, each note and half note having its separate pipe, and each parallel row representing a different instrument; the pipes producing the same note in every instrument lying in a straight line from front to back of the instrument, or parallel to its sides. Thus the pipes producing the note *A* on the flute, clarionet, bassoon, &c., all lie in a parallel to the sides of the instrument. From the upper part of the wind chest proceeds a horizontal platform, termed the bottom board, having a series of channels cut in its upper surface, corresponding to each note of the different scales, and extending longitudinally from front to rear of the machine. Above the bottom board, and at right angles to the channels, are a series of grooves, corresponding to the transverse ranges of pipes, or the number of the different instruments in each groove, are three slides, placed one over the other, and through all three are narrow passages, opening into each of the wind channels in the bottom board. Over the slides is placed the top board, into which the pipes are inserted, communicating with the wind channels through the apertures in the slides. The use of these slides is to cut off occasionally the communication of any particular instrument with the wind chest, so as to cause that instrument to cease playing, which is effected as follows:—the space between each aperture in the slides is somewhat greater than the width of the wind channels, so as to cover the channels completely, and thereby cutting off the communication with the instrument to which the slide belongs. Only one slide in each set of slides is in operation at one time; the apertures in the other two sets being over the wind channels, and below the apertures of the instruments. One set of slides being used when the instrument is played by the mechanical action of the machine, another set is moved by pedals, and the third set by hand, when it is played by the keys. At that end of each wind groove that opens into the wind chest, are two hanging valves, called pallets, which admit the air into, or exclude it from, the wind grooves; and the art of performing upon the machine consists in the management of the pallets and stops before described; the air or tune being produced by the pallets, and the stops regulating the instruments, upon which the air is played. The machine may be played in two ways, either by performers seated at ranges of keys, as in other organs, or by mechanical means: and as this latter method is the distinguishing character of the machine, and has called forth so much ingenuity in its execution, we shall describe it first. The principle is as follows:—to one set of the pallets is attached a series of wires (one to each pallet) passing through holes in a brass plate in the bottom of the wind chest, which are just sufficiently large to allow the wires to move easily, without allowing the air to escape from the wind chest. These wires (60 in number, being one to each note of the scale of the machine,) are connected to one end of a series of small steel levers, set in a frame below the wind chest, the outer end of the levers resting upon the surface of a cylinder somewhat longer than the key-frame; a number of small pins and bent wires or brackets project a short distance beyond the circumference of the cylinder, ranged in lines across the axis, and by the revolution of the cylinder, one or more of these pins or brackets are brought in contact with the outer end of the keys, which are thus raised, whilst the other end of the keys, and the pallets corresponding, are proportionably depressed; the wind passes from the wind chest into the wind passages. The length of time the pallets continue open is regulated by the length of the brackets; and when, by the revolution of the cylinder, the brackets come clear of the keys, the outer end of the key falls upon the cylinder, the pallet is closed by a spiral spring, and the communication with the wind grooves is cut off.

There are three cylinders, each 2 feet in diameter, and each having a separate wind chest and key-frame placed over it, furnishing wind to particular portions of the scale. The main cylinder occupies the centre of the front of the machine; it is 8 feet long, and comprises a range of five octaves: viz., from G G, an octave below first G in the bass clef up to G, and eighth above G in the treble clef. In a line with this, and concentric with it, is another cylinder, 3 ft. 9 in. for the bass notes extending from G G G, or an octave below the former, up to gamut G, being two octaves. The third cylinder lies at the back of the machine, parallel to the main cylinder; it is 8 feet long, and comprises two octaves. Below the two front cylinders extends a shaft, or axis, having two pinions, which work in two wheels, one on the end of each cylinder, and a similar shaft lies below the third cylinder, in the rear of the machine; and beneath these shafts, and at right angles to them, is another shaft, extending from the front to the back of the machine, having on it two endless screws, working in worm-wheels on the two shafts: this last shaft receives its motion by a band from the driving-shaft, (which has a fly-wheel, and is turned by manual labor), and causes the cylinders to revolve. The key-frame is made in distinct pieces, to allow for the unequal contraction of the wood, and any inequalities which may exist in the cylinder; and to take the weight off the key, it is supported on the cylinder by anti-friction rollers. It remains now to explain the connexion of the finger-keys with the pallets. The key-boards are five in number, the central largest comprising a scale of five octaves, and the smaller ones disposed two on each side of the larger, these containing a scale of three octaves. These keyboards stand in front of the instrument, and detached from it, so that the performers sit with their backs to the instrument, and their faces to the audience. From the fore end of the finger keys descend wires to the fore end of a series of levers below the floor, and to the other end of these levers are attached wires, which pass through holes in the wind chest, and are fastened to their set of pallets, and thus the depression of the finger keys draws down the hinder ends of the lower levers, and opens the pallets. Within reach of the performers at the keys, are a number of levers for moving by hand the draw-stops as are termed the slides which throw off or on any particular instrument; but, in addition to these, are a set of pedals five in number, which move a set of stops, called compound pedal stops. These are the invention of Mr. Robson, and are for the purpose of enabling the performer suddenly to throw on or off a number of instruments by a single movement, and thereby add greatly to the brilliancy of effect.

The whole number of the keys acted upon by the cylinders is about 250. There are upwards of 1900 pipes, 45 drawstops, and 2 kettle-drums. To the musical amateur the following list of the stops will doubtless prove interesting.

On the first cylinder,—

1. Open Diapason
2. Ditto ditto.
3. Stop ditto.
4. Principal.
5. Twelfth.
6. Fifteenth.
7. Flute.
8. Sesqui Altera.
9 Cornet—Trumpet.

On the second cylinder are two octaves of wooden pipes, of large dimensions, termed double diapason pedal pipes: the largest is 21 feet long, and 23 inches square; this is 8 feet longer than the corresponding pipe in the great organ at Haarlem. The range of the scale is from G G G to G.

On the third cylinder are the following stops,—

Diapason, or Corni Stop.
Stop Diapason.
Violoncello.
German Flute
Wood Fifteenth.
Trumpet.
Cremonas.
Flutes
Vox humana.
Octave Flute.
Hautboys.
Piccolas.
Trumpets.
Diapason.
Principal, &c.

The mechanism is inclosed in a case, 20 feet broad by 18 feet deep, and 24 feet high. The front is divided into three compartments by pilasters of Grecian Doric, surmounted by others of the Ionic order. Between the upper pilasters are three paintings; that in the centre representing Apollo, and those on the sides the Muses, Clio and Erato, somewhat larger than life, which do much credit to the artist, (Mr. John Wright) by whom they were painted. The mechanical action of the apollonicon was first exhibited to the public in June, 1817, when the overtures to Anacreon and to the Clemenza di Tito, were performed by the cylinders in a style that called forth the most marked approbation from large and scientific audiences. From that period to the present time it has maintained its well-deserved popularity, and continues an object of interest alike to the musician and the mechanist, offering to the former some of the grandest combinations of harmony, and to the latter some of the most curious and complicated specimens of his art.

FULMINATING COMPOUNDS.

The most remarkable instances of expansion by heat with which we are acquainted, are those where explosive mixtures are used, and where reverberation of the air is the consequence. In the explosion of these compounds (which are of various kinds), the simple substances of which they are composed are either resolved into their primary states, or they immediately enter into combination with other substances, which, like themselves, have just been liberated. In most cases, they not only assume but retain the elastic form. The explosion of these bodies is doubtless owing to their combination with heat; but whether the heat has been *latent* in themselves, or whether they are capacitated by a slight elevation of temperature, suddenly to rob the surrounding atmosphere of its heat, is not known.

If 1 ounce of oil of turpentine be poured into a gallipot (placed in the open air), and 1 ounce of nitric acid, with 20 drops of sulphuric acid, into a phial tied to the end of the walking-stick; the acid on being thrown upon the oil (at arm's length, to prevent accident) will cause deflagration:—abundance of light and heat being evolved.

Cover up some small pieces of charcoal in a crucible, and give them a red heat. When perfectly hot, uncover the crucible, and pour some sulphuric acid upon them from a phial tied to the end of a stick; immediate deflagration will take place from the rapid decomposition of the acid, part of which will be thrown out, by the quick disengagement of carbonic acid gas. When the action has subsided, sulphur will be found precipitated on the charcoal. Here the charcoal, in the red-hot state, has more affinity for oxygen, than sulphur has in the state of sulphuric acid; the consequences are, the formation of carbonic acid and the precipitation of sulphur.

Melt some antimony in a crucible, and when at a white heat, pour some water into a small retort, and hold it over a lamp. When the steam passes out, hold it over the crucible containing the antimony, so that the steam may enter into or pass over it. At this instant, let an assistant agitate the crucible by a pair of tongs; a series of very violent explosions will take place, as the water, in the form of steam, is decomposed. Here the oxygen combines with the metal, and the hydrogen is set free.

Mix together 1 dram of sulphur, 3 drams of nitrate of potass, and 2 drams of carbonate of potass, (all previously pulverised) in a sheet of writing-paper. When properly mixed, put them into a small stoppered phial. An eighth, or a sixteenth part of this, put on a fire-shovel, or tin plate, held over the fire for a few minutes, will explode; immediately before the explosion, a violet-colored flame will be seen to hover round it.

Reduce separately to fine powder, 4 ounces of nitrate of potass, 2 ounces of the sulphuret of antimony, and 1 ounce of sulphur; mix them well on a sheet of paper with a wooden or ivory spatula. and preserve the compound in a dry phial. When it is to be used, lay about a dram, or more, on a piece of wood or iron, and fire it with a red-hot iron wire; instant deflagration, accompanied by dazzling light and great heat, will take place.

Reduce to powder 10 grains of nitrate of silver, and then mix with it 4 grains of sulphur; wrap the mixture in a small bit of paper, and place it upon an anvil; make a hammer which has a broad surface pretty hot, and strike the mixture with it; a violent explosion will take place, and upon examination the silver will be found in a reduced or metallic state. If the hammer be cold, the sulphur only will be affected; it will then inflame without detonation.

If 10 grains of charcoal, in powder, be mixed with 10 grains of nitrate of silver, also in powder, and laid on an anvil, wrapped up in paper, an explosion will take place when they are smartly struck by a hot hammer.

If 6 grains of the nitrate of silver are powdered and mixed with 2 grains of phosphorus in a piece of writing paper, then put upon an anvil and struck with a hammer, a very violent explosion will take place. Nitrogen and phosphoric acid will be disengaged.

Place a crystal of nitrate of ammonia on a shovel, and hold it over the fire; when it has arrived at a heat sufficient for melting lead, it will, in the act of decomposition, explode with considerable violence.

Place 12 grains of nitrate of copper, in powder, mixed with 2 grains of phosphorus, upon an anvil, and strike them with a hot hammer; detonation will be the consequence. The salt will be decomposed, giving out nitrogen gas. Phosphoric acid gas also will be formed, from the union of the phosphorus with the oxygen of the nitrate.

If a pestle and mortar are for some time kept warm before the fire, and a ready-formed mixture of 12 grains of sulphur and 12 grains of nitrate of lead, be thrown in, and smartly triturated, explosions will take place. The lead will resume its metallic state, whilst nitrogen and sulphurous acid gas will be evolved.

If 4 grains of nitrate of mercury are reduced to powder, and combined with 2 grains of phosphorus, a most violent explosion will take place, when they are struck smartly by a hot hammer on an anvil. Globules of reduced mercury will be found upon examination of the paper which contained this mixture. Nitrogen gas and phosphoric acid will be disengaged; for the oxygen of the salt combining with the phosphorus, forms phosphoric acid, which flies off; the nitrogen being thus left free, absorbs caloric, and becomes elastic also, whilst the metal recovers its properties.

Triturate in a mortar, 2 grains of phosphorus with 4 grains of nitrate of bismuth; during this operation, violent detonations will take place.

Reduce separately to powder, 1 ounce of alum and 1 ounce of raw sugar. Melt them in an iron ladle over a clear fire, stirring the mixture until it becomes dry. Reduce the compound to powder in a mortar when cold. Now pour the powder into a strong 4 ounce phial, into which lute a tobacco-pipe, preserving the bore of the pipe free from particles of the lute; imbed the phial in a coat of clay, and immerse it thus in a crucible, filling up the space between it and the sides with sand. Place the phial with its contents in a good fire. Carburetted hydrogen gas will escape from the upper end of the tube, and when this ceases, stop it up with a piece of clay; now remove it from the fire, and let it get cool: when cold, take out the pipe, and quickly insert a cork, (at the same time remove the clay), and lay it by for use. This is called Homberg's pyrophorus, and if a little of it be poured at any time from the mouth of the phial, it will spontaneously take fire.

Into a cup containing 2 drams of sulphuric acid, throw 3 or 4 grains of chlorate of potass; immediate combustion and explosion will take place, the chlorine will be liberated, and sulphate of potass will be formed.

If 2 grains of powdered charcoal and 4 grains of chlorate of potass be carefully mixed in a piece of paper, then folded up and placed upon an anvil,—upon being struck by a hammer, a violent detonation will take place.

(To be continued.)

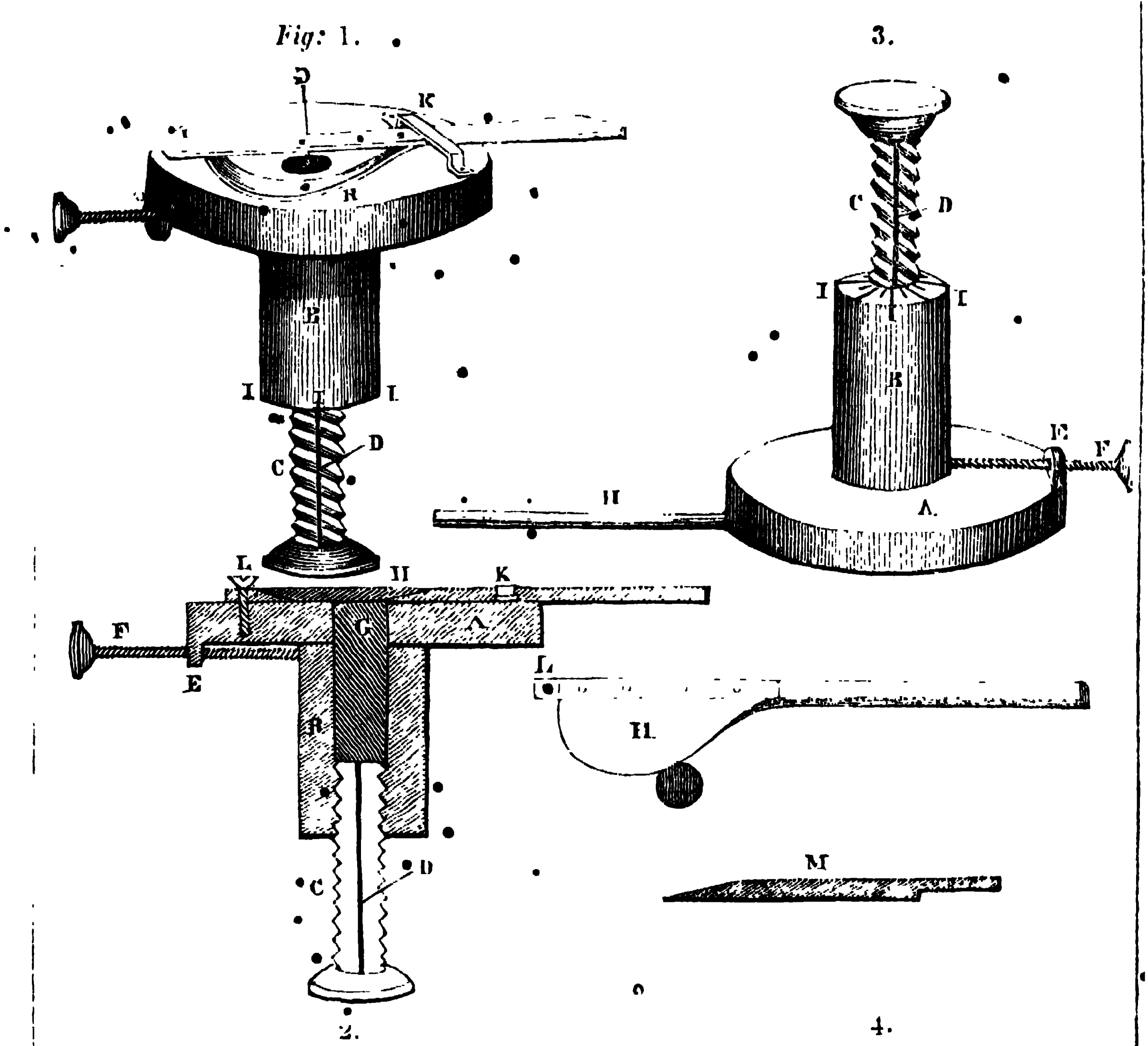
MEMORANDA.

Fossil Infusoria.—M. de Humboldt has recently presented to the Academy of Sciences at Paris, in the name of M. Ehrenberg, specimens of a peaty argillaceous deposit, lying 20 feet below the pavement of the city of Berlin, and filled with infusoria still living. Traces of this subterranean life are observable 3 feet below the bottom of the Spree. Since 1836, when M. Ehrenberg first called attention to the immense masses of fossil infusoria, or microscopic animals, in the more recent formations, he has had occasion to observe, that the organic forces are still so active in the mud of ports and rivers, that at Swienemunde, in the Baltic, for example, where above two and a half millions of cubic feet of mud were recently removed in one year, one-third of that entire mass consisted of microscopic animals. The moors of Limburg present accumulations of fossil infusoria 28 feet in thickness. In the peaty layer of Berlin, tunnel-shaped deposits of eggs reach, in some places, to the depth of 60 feet. There is no doubt that they are still alive and capable of increase. Spontaneous motion may be often observed in specimens taken from the greatest depth, though less frequently than in those near the surface. M. Ehrenberg, in whose hands the microscope has revealed such wonders, is about to produce a work on fossil infusoria, similar to that which he has already published on the living species of microscopic animals.

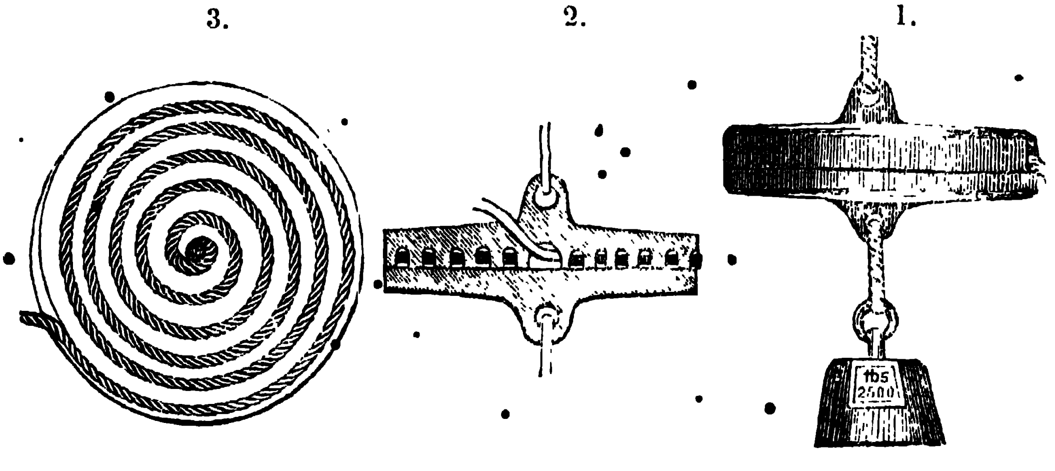
Indigo.—It is said to be proved by experiment, that the indigo plant *(Polygonum tinctorium)* may be successfully cultivated in France. M. Jaume sowed some of the seed in the beginning of April; at the end of July he stripped off the leaves of 16 of the plants, and divided the stalks so stripped into 144 cuttings, which, being planted, all succeeded, so that by this simple mode of culture, he increased his plant tenfold. The leaves of the original 16 plants, yielded 1,400 grammes (about 22 grains) of indigo.

Music of Nature.—Gardiner, in his *Music of Nature*, has put into notes the songs of twenty-four birds, and twenty animals. Also about twenty expressions of human passion and feeling, and tones of eight or ten insects. The *gnat* gives the note A on the second space. The *death-watch* calls in B flat, and an answer in G. The three notes of the *cricket* are in B. The buz of a *bee-hive* is in F. The wings of the *house-fly* are F in the first space. The *humble-bee* is an octave lower. The *cockchafer* is F below the line.

Water is a better conductor of sound than air. Wood also is a powerful conductor of sound, and so is flannel or ribbon.



NEW INSTRUMENT FOR CUTTING SECTIONS OF WOOD FOR THE MICROSCOPE.



RADFORD'S ELECTRO-MAGNET.

NEW INSTRUMENT FOR CUTTING SECTIONS FOR THE MICROSCOPE.

Sir,—Annexed I beg to hand you sketches of an instrument constructed some time since, for the purpose of cutting sections of wood for the microscope, the size and simplicity of which will, I think, prove a sufficient recommendation to a place in your pages, in addition to what has already appeared.

Your interesting paper on the subject in vol. I, page 115, leaves nothing but description necessary in this case, as the application is the same in both; this the reference will in some measure supply. It should however be mentioned, that the male screw C, is tapped with 25 threads to the inch, so that a $\frac{1}{4}$ of a turn equals an elevation of $\frac{1}{100}$ of an inch, $\frac{1}{8}$ $\frac{1}{200}$, $\frac{1}{16}$ $\frac{1}{400}$, and so on. It would also be an advantage if the blade of the knife were made semicircular, as it would be easily and regularly sharpened by fixing it on a circular piece of wood, its own diameter, with level edge, to the face plate of a lathe, and applying the stone or strop while it was in motion. The blade is made with a curved edge to obtain a sliding cut. I am, Sir,

Faithfully yours,

Beersey House, Warrington T. G. R. RYLANDS.

A a brass plate, 3 inches in diameter; B a brass tube, 1½ inch long, (both cast in one piece.) C a brass screw, to elevate the wood. D a mark filed up to act as a gnomen to I I I. E a bush cast upon A, to hold the iron set screw F, which steadies the wood. G the hole, into which the wood is inserted. H the knife, which works on the screw I, under the guard K. I I I marks filed in B, to graduate the thickness of the section cut. K the guard under which the knife works, and M a section of the knife blade. Fig. 1, a drawing of the instrument, Fig. 2, a section of ditto. Fig. 3, a reverse drawing of ditto. Fig 4, the knife, with the wood hole G in its relative position.

RADFORD'S ELECTRO-MAGNET.

The following account of this truly original instrument has already appeared in "The Annals of Electricity," from which work we copy it, together with the letter of Mr. Sturgeon, the editor, to Mr. Radford on the subject of his invention, in the opinions of whom we fully agree:—

"Dear Sir,—Herewith I send you the new electro-magnet which I commenced experimenting upon early in October last, and beg your acceptance of it. The drawings will explain its character very plainly:—

No. 1 being the elevation.
No. 2 ,, the vertical section.
No. 3 ,, the convoluted face.

It is nine inches in diameter, and the sketches being drawn to scale the other dimensions can be ascertained easily.

The magnet weighs, exclusive of the copper coil, and the keeper, sixteen pounds and two ounces.

The coil is a bundle of twenty-three small copper wires, and weighs two pounds two ounces.

The coil is covered with cotton tape.

The keeper weighs fourteen pounds fourteen ounces and three quarters.

The depth of the convoluted groove or recess, is $\frac{3}{8}$ of an inch and $\frac{1}{4}$ of an inch wide.

The width or breadth of the metal between the grooves, as shown in the section, is half an inch.

The thickness of the magnet is one inch, at the outside edge, and about $\frac{3}{8}$ in the centre.

Before it was finished, an experiment was made on the 3rd of December, 1840, and it sustained a load of 2141 pounds, with eight of your battery jars.

The greatest weight was lifted on the 17th of December last, by a battery of yours, with twelve jars, and the weight sustained was 2500 pounds avoirdupois.

If you think this worth a place in your "Annals," I shall feel obliged by your insertion of it.

Yours, faithfully,

JOSEPH RADFORD."

Mr. Sturgeon's Answer.

"Dear Sir,—By your kindness in presenting to me this piece of apparatus, which, amongst many other favors, I take a pleasure in availing myself of this opportunity to acknowledge; you have put me in possession of the most curious and extraordinary magnet that has ever yet appeared on the pages of science, or ever has been placed in the cabinet of philosophy.

The convoluted figure of its face is not only a great curiosity, but a perfect novelty in magnetics; and the unusual arrangement of its poles, both of which are on the *same* convoluted strip of iron, (which forms the face,) one pole occupying the whole length on one edge, and the other the whole length of the opposite edge: together with its great powers, render it a piece of apparatus of extraordinary character and great interest; and will, no doubt, command a great deal of attention amongst electro-magnetists. Yours, truly,

W. STURGEON."

TO FIND THE FOCUS OF LENSES AND SPECULA.

The focal distances of lenses are easily discovered by experiments, and, among others, we have selected the following:—

1. When the focal length of the lens does not exceed two or three feet, it may be found by holding the lens at such a distance from the wainscot, opposite a window sash, that the image of the sash may be distinct upon the wainscot; and this distance may be considered as the focal length of the lens; but if the focal length is great, the focus must be computed by the subsequent rule.

Rule. Measure the distance between the lens and the object, and also from the image; multiply these distances together and divide the product by their sum; the quotient will give the focal distance: or, the square of the distance of the observed focus, divided by the distance of the object from the image will give the excess of the observed focus beyond the true focal distance.

2. When you find the focus by making a candle the object, and the paper for receiving its image, so that when the image is most distant the lens may be exactly between the other two, then halve the distance between the object or its image and the lens for the focal distance.

3. If a small hole, about one-fourth or one-eighth of an inch be made in the window shutter of a darkened room, and a lens and piece of paper be held behind this hole at proper distances, the place where the image of the hole is most distinct may be determined very critically, and from them the focal length may be found by the foregoing rule.

4. By the sun's image: Place the lens so that its axis may point as near as possible to the sun; then holding a paper opposite thereto, the burning point,

or where the image of the sun is smallest, and the limb most distinct is the focus. This method is sufficiently accurate for spectacle glasses, and such as are broad in proportion to their focal length; but will not answer for lenses of a long focus, unless they are sufficiently long to exhibit the solar spots; because in these cases the image is only a glare of light without distinctness; but the inconveniences may be removed by the following method:—

5. Cover the lens with a piece of pasteboard or paper, and make two round holes therein at an equal distance from the edge of the lens and on one of its diameters. The lens being thus covered, point its axis to the sun: now if a paper be held behind the lens, you will find the two circles, or white spots, produced by the two holes, gradually approach nearer to each other as the paper is moved further; at last they will unite, and if the paper be moved still further they will again separate. The distance of the paper from the glass when the circles unite being measured gives the focal distance.

To find the focus of a plano-convex and a plano-concave lens:

By experiments similar to the above may be found, 1. That the focus of a plano-convex, or of a plano-concave glass, is equal to a diameter of its convex or concave surface, that is, of the whole sphere it belongs to.

2. That the focal distance of a double convex, or double concave glass, of equal convexities or concavities, is equal to a semi-diameter of either of its surfaces; and consequently that the focal distance of a glass of unequal convexities or concavities, will have an intermediate strength between a diameter and semi-diameter of that surface which is most convex or concave.

To measure the focal distance of a globe of water and of glass:

Take a hollow globe of glass, or instead of it, a thin round flask, or decanter, and making a round hole, about an inch in diameter, in a piece of brown paper, paste it on one side of the body of the decanter; and having filled it with water, hold the covered side to the sun, that the perpendicular rays may pass through the middle of the water and the emergent rays will be collected to a focus, whose nearest distance from the decanter will be equal to the semi-diameter of the body of it, as will appear by receiving the rays upon a paper held at that distance. That this effect is owing to the water and not to the glass, will be evident by emptying the decanter; for the light that then passes through the hole will be as broad as the hole itself at all the distances of the paper from the decanter. If a similar experiment be tried with a solid globe, or ball of glass, the distance of the focus from the nearest part of the ball will be one quarter of its diameter.

To find the vertex, or centre of a lens:

Hold the lens at a proper distance from the eye, and observe the two reflected images of a candle made by the two surfaces. Move the lens till these images coincide, and that point is the vertex; and if this be in the middle of its surface the glass is truly centred, otherwise it is not.

Whatever be the shape and magnitude of the hole, in the paper that covers part of a lens, the shape and magnitude of the image will be the same as when the lens is uncovered; because any small part of a pencil of rays has the same focus as the whole; but the brightness will be diminished in proportion as the hole in the cover is diminished; because the quantity of light which illuminates every point of a picture is diminished in that proportion.

In order to obtain a competent knowledge of refraction, and the properties of lenses, the student, who has not previously been made acquainted with mathematics, should make experiments with lenses of different foci, diameters, and colors; the room should be quite darkened, and the sun's rays admitted through an aperture cut in a shutter, or a tube for that purpose placed therein, and moveable by an universal joint, or ball and socket. His lenses should be fitted in cells, connected to a sliding board or frame, or adapted to stands and frames of wood or brass. By such contrivances he may combine any sort of lenses together as may be necessary, either separately, or close together; he might also have lenses ground to the figure of a meniscus, or of a watch glass, and connected in one frame, so that fluids might be included and the properties of refraction by fluid lenses exemplified. A few experiments in this manner will afford the most evident and entertaining proofs of the laws of refracted rays. The dust usually in motion will in the darkened room give the various and natural figures of the converging and diverging pencil of rays.

To find the focal length of a spherical speculum:

1. For a concave speculum. Place the speculum so that its axis may be nearly towards the centre of the sun. Find the burning point, or receive the image upon a white piece of paper; and the distance between the focus so found, and the vertex of the speculum, is the focal length. Or, cover the speculum with a sheet of opaque paper, in which make two or more holes, and observe where the beams of light, reflected from these holes unite, and this will be the focal distance. Or, lastly, place the speculum at the end of a long table, in a vertical position; place a candle at the opposite end of the table so that its flame may be opposite to the vertex of the speculum; then take a piece of white paper and having fixed it to a stick, place the stick in the socket of a candlestick so that the paper may be supported at about the same height with the candle; then move the paper or the candle forwards and backwards till the image of the candle on the paper is exactly over the candle itself, and the point of coincidence is the centre of the speculum.

2. For a convex speculum. Cover it with paper, having two pin-holes made, one near each edge of the mirror; expose it to the sun, holding another paper before it having a hole large enough to let the solar rays pass through to the two pin-holes. Two white spots of reflected light will be seen on each side of the hole: move the paper backward and forward, till the distance of the spots be twice the distance of the holes in the cover; and that distance of the paper from the mirror is the principal focus.

SCULPTURE IN GREAT BRITAIN.

THE thousands who visit our annual exhibition at the Royal Academy, and other galleries where sculpture forms, if not a principal, a large portion of the collections, are in total ignorance of the means by which such objects are produced. The general belief is, that the statue, or group, hewn without previous labour from the rough block, is completed at once by the sculptor, and that the greater the finish or smoothness that may decorate the work, the more talent is manifested and credit due; but with the artist and the educated in art, it is simply considered a mechanical termination, unworthy, in every respect, of consideration, unless applicable to a well-selected subject, well told, and with judgment drawn; and even then, as a pleasing auxiliary only. Mind and sentiment are the chief; and though certain materials may be more pleasing to the eye, and, in many cases, enhance the general effect, still the work, without these requisites, would be, *in place of art*, that of *mechanical labour*. With the multitude, nay, with many educated people, an impression exists, that the whole art of statuary lies in the execution of the marble, a truth evinced by the manifest indifference which may be observed at our exhibitions for the *plaster* productions of genius, while trifles wrought in the more expensive material rivet attention, and draw forth expressions of the greatest admiration. Sculpture has not only been long a misunderstood, but a neglected art. Let us visit the numerous galleries and exhibition-rooms of our own country, and we shall then obtain sufficient proof of the fact. Our Royal Academy, our *British Institution*, and the Suffolk-street Gallery, are all instances. The National Gallery, though hung throughout with pictures, boasts ONE ONLY specimen of the sister art! At Manchester, Liverpool, and Birmingham—indeed, at all our provincial exhibitions —the accommodation for sculpture is totally neglected; and though repeated premiums are offered for the encouragement of painting, in no case has a corresponding feeling been evinced for the patronage of statuary. Let us visit Paris, and the same neglect becomes apparent. Windows, far beneath the many glorious works of antiquity which adorn the Louvre, destroy the mastery with which they are wrought; though on proceeding to other halls, we find every accommodation afforded for the exhibition of pictures. Milan, Bologna, and Florence are equally regardless of their statuary in respect to light; and even (in many instances) the Eternal City, the mart of sculpture, is open to the same remark. The last slight which this noble art sustains remains untold. See our daily and our weekly papers, nay, our journals of art and science—see the column after column noticing the productions of the pencil, and then the *infantile* paragraph, stating simply that sculpture too is there.

The first idea of the sculptor is traced either in clay or on paper; a small and rough sketch of the subject he wishes to produce, in which he considers well his tale, and the best mode to convey it, the most agreeable position for his figures, and the general effect of the whole, totally neglecting every appearance of detail or smoothness. When this draught is completed agreeably to his wishes, he commences (with the assistance of his workmen) to pile up a mass of clay the size of the object to be pourtrayed, rendering it firm and steady by the addition of irons and frame-work, secured to the stand on which it rests; and on the careful completion of this—the model—depends the correctness and beauty of the marble. It is at this stage that the draught or original idea is reconsidered, copied, and, with the assistance of the human figure, more minutely studied and carried on to completion. The moist nature of the clay renders some mode necessary for the preservation of the model during the progress of carving, or being *copied* in marble, and this is effected by moulding and casting, as follows:—The clay—for instance, a statue—is at first covered on the front half only, from the summit to the base, with a mixture of plaster and water, which is allowed to become hard, or set, previously to the remaining portion of the figure being covered, when the object is entirely coated, and the mould completed. A sufficient time having elapsed to render the mould firm, it is carefully removed in two parts from the clay, when an exact representation of the statue is shown in reverse. These, being thoroughly cleansed, are placed securely together, and filled with plaster of a finer nature, and in turn an impression is taken off the mould; this being carefully cut away, leaves a cast, similar in every respect to the original model. The plaster cast is now placed in the hands of a mason, who by means of a machine proceeds with the pointing or roughing out. By this process the waste stone gradually diminishes, and the form daily becomes more and more apparent, until within an inch or less of its intended surface, when it is submitted to the chisel of the sculptor's more able assistant, who carries it still nearer to the *perfection of the model*, and prepares it for the final touches of the master.—*The Art Union.*

CHANGES OF THE KALEIDOSCOPE.

THE property of the kaleidoscope, which has excited more wonder, and therefore more controversy than any other, is the number of combinations or changes which it is capable of producing from a small number of objects. Many persons, entirely ignorant of the nature of the instrument, have calculated the number of forms which may be created from a certain number of pieces of glass, upon the ordinary principles of combination. In this way it follows, that twenty-four pieces of glass may be combined 1391724288887252999425128493402200 times, an operation, the performance of which would take hundreds of thousands of millions of years, even upon the supposition that twenty of them were performed every minute. This calculation, surprising as it appears, is quite false, not from being exaggerated, but from being far inferior to the reality. It proceeds upon the supposition that *one* piece of glass can exhibit only *one* figure, and that *two* pieces can exhibit only *two* figures, whereas it is obvious that the two pieces, though they can only be combined in two ways, *in the same straight line*, yet the one can be put *above* and *below* the other, as well as upon its right side and its left side, and may be joined, so that the line connecting their centres may have an infinite number of positions with respect to a horizontal line. It follows, indeed, from the principles of the kaleidoscope, that *if* only *one object is used, and if that object is a mathematical line without breadth, the instrument will form an infinite number of figures from this single line.* The line may be placed at an infinite number of distances from the centre of the aperture, and equally inclined to the extremities of the reflectors. It may be inclined at an infinite variety of angles to the radii of the circular field, and it may be placed in an infinite variety of positions parallel to any radius. In all these cases, the kaleidoscope will form a figure differing in character and in magnitude. In the first case, all the figures are polygons of the same character, but of different sizes. In the second case, they are stars, differing from each other in the magnitude of their salient and re-entering angles; and in the third case, they form imperfect figures, in which the lines unite at one extremity and are open at the other.

If, instead of supposing a mathematical line to be the object, we take a *single piece* of colored glass, with an irregular outline, we shall have no difficulty in perceiving, from experiment, that an infinite variety of figures may be created from it alone. This system of endless changes is one of the most extraordinary properties of the kaleidoscope. With a number of loose objects, it is impossible to reproduce any figure which we have admired. When it is once lost, centuries may elapse before the same combination returns. If the objects, however, are placed in the cell, so as to have very little motion, the same figure, or one very near it, may, without difficulty, be recalled; and if they are absolutely fixed, the same pattern will recur in every revolution of the object plate.

ANCIENT MASONRY.

The earliest masonry known to us is probably that of the Egyptians, which is chiefly remarkable for the enormous size of the stones employed, said to be frequently thirty feet in length: the weight of these masses rendered the use of mortar unnecessary, once placed, they were never likely to be removed; whilst their size also rendered the use of the arch in most cases unnecessary, a single stone being sufficient to cover almost any opening that they required, although there are some vaults constructed of large masses of stone laid horizontally, and overlapping each other until they meet in the centre.

Of Cyclopean masonry the most celebrated remains are the walls at Tiryns and Mycenæ; their date is unknown, but as they are alluded to by Homer, they are necessarily of high antiquity; these walls are formed of large and irregularly-shaped masses of stone laid together without mortar, and the interstices filled with smaller pieces.

Tyrrhenian or Etruscan masonry consists also of large and irregularly-shaped masses of stone, but fitted together with considerable exactness, so as not to admit of smaller stones in the joints or interstices: of this kind of masonry many specimens exist among the ancient remains of Greece and Italy. The next improvement in masonry appears to consist in working the stones sufficiently to render the horizontal joints (or bed) in great measure flat and true, the vertical joints being reduced to a straight surface only, and not made perpendicular; and the courses also are more or less irregular; examples of this kind of masonry are to be found at Fiesole, Populonia, and many other places. All of these kinds of masonry were put together without any kind of mortar. The stones also were of very large dimensions; the usual size of those of the walls of Tiryns is about seven feet by three, but some are larger; so also are they in some of the other specimens.

In the ruins of Palmyra and Balbec all travellers agree in remarking the enormous dimensions of the stones employed; for instance, at Balbec, "On the west side of the basement of the great temple even the second course is formed of stones which are from 29 to 37 feet long, and about 9 feet thick; under this, at the north-west angle, and about 20 feet from the ground, there are three stones which alone occupy 182 feet 9 inches in length, by about twelve feet thick; two are 60 feet, and the third 62 feet 9 inches in length."

For ordinary purposes, the ancients used several kinds of walling, as the "opus incertum," now called "random" or "rubble" walling, made with stones of irregular shapes and sizes; the "opus reticulatum," so called from its net-like appearance, formed with square stones laid diagonally, and this Vitruvius mentions as being common in his day; "isodomum" and "pseudisodomum," which Vitruvius ascribes to the Greeks, were formed in regular courses, in the first all of equal height, but in the latter of unequal height; "emplectum" resembled the two last in external appearance, but the middle of the wall was of rubble, the facing only being in regular courses: in all these sorts of masonry the stones were small, and were laid in mortar. The ancients also frequently erected walls of brick, both burnt and unburnt. In the erection of large buildings, in which large blocks of stone were used, the Romans used no cement. In the later times of the empire, it appears that the masonry called "emplectum" was most commonly used; as this kind (either with or without occasional courses of tiles) is that which is usually found in this country and in France; the courses are usually 4 inches deep, the stones in most instances of rather cubical proportions, and the joints commonly wide and coarse. This kind of masonry also, without the bonding courses of tiles, was manifestly used after the Romans were subdued, for it is to be found in the walls of the old nave of the cathedral of Beauvais (called Notre Dame des Basses Œuvres), those of the nave of St. Remi at Rheims, of St. Pierre, at Le Mans (if any of this building still exist), and in the walls of the keep of the Château of Langeais on the banks of the Loire; none of which buildings are of Roman date.

In England, the existence of any remains of the Saxon period is doubted by many of our best antiquaries, but it would appear without sufficient grounds, as the class of buildings disputed have a very different character from Norman work, and are equally distinct from Roman. The masonry of these buildings consists chiefly of rude rubble-work, and we frequently find Roman bricks worked up irregularly into the walls, sometimes in herringbone fashion; but the chief peculiarity in the masonry of these buildings consists of the particular manner in which the cut stones at the angles used as quoins are arranged, called "long and short work."

In early Norman times the walls on the inside had a rubble face, and were plaistered, and had frequently an external face of rubble as well, and perhaps were occasionally plaistered also on the outside: when the external face was of ashlar, the joints were always coarse and large, and the mortar most commonly made with very coarse unsifted sand or gravel; the stones also are generally in shapes approaching cubes, and vary in depth from about 6 to 9 or 10 inches. During the former part of the twelfth century the masonry improved considerably; the mortar was made of finer materials, and the stones were set with a neat and close joint, but they had still an approach to a cube in their shapes. Rubble has been used at all times up to the present day. Herringbone work has been called by some a sign of early work, but others regard it rather as a sign of late Norman. Guildford Castle is late Norman, and has a good deal of herringbone work in its walls. "Opus reticulatum" is occasionally found in late Norman work, as at the west end of Rochester cathedral. There is also another kind of masonry sometimes found in late Norman work, which appears to be used by way of ornament (as in fact is the "opus reticulatum"), and of which a specimen may be found in the tympanum over the south door of the small desecrated and ruinous chapel of West Hythe; perhaps it may be called herringbone ashlar. In the nave of the cathedral at Bayeux are several varieties of masonry introduced to ornament the walls, all which are late Norman. After the expiration of the Norman style there is seldom, if ever, any fixed character in the masonry to evince the date of a building; but it may be observed, that in the fourteenth century the stones employed are generally smaller than at a subsequent period, and that there is generally a marked difference between modern masonry and that of the middle ages, which the eye at once detects, and which is often useful in pointing out insertions and alterations.

QUALITIES OF BAD PAPER.

In order to increase the weight of printing paper, some manufacturers are in the habit of mixing sulphate of lime, or gypsum, with the rag to a great extent. I have been informed, by an authority upon which I place great reliance, that some paper contains more than one-fourth of its weight of gypsum; and I lately examined a sample, which had the appearance of good paper, that contained about 12 per cent. The mode of detecting this fraud is exceedingly simple: burn 100 grains, or any given weight of the paper, in a platina or earthen crucible, and continue the heat until the residium becomes white, which it will readily do, if the paper is mixed with gypsum. It is certainly true that all paper contains a small quantity of incombustible matter, derived from accidental impurities, but it does not amount to more than about one per cent.; the weight, then, will indicate the extent of the fraud."—*Brande.*

The professor just quoted also mentions a circumstance of a Birmingham button-maker, who had a large quantity of newly-made buttons, so much tarnished as to be unsaleable; and upon examining into the cause, it was found to be owing to their being left in the paper, in which the buttons were wrapped up, a considerable quantity of chlorine, or oxymuriatic acid, which is used in the bleaching. There are very few goods that would not be injured by the action of chlorine.—A colored paper manufacturer would find it difficult to fix any vegetable color upon paper so impregnated—and the loss to him might be very serious. Great caution is therefore necessary in the purchasing of paper for such purposes

ENGRAVING IN IMITATION OF BLACK-LEAD OR CHALK.

A remarkably good polish must be put on the copper with an oil rubber and crocus-martis well ground in oil; after which it must be cleaned off with whiting, and then rubbed with another clean rag. You are then to pour over your plate the solution to cause ground, which is made as follows:—

No. 1. Three ounces of Burgundy pitch; one ounce of frankincense. These are to be dissolved in a quart of the best rectified spirits of wine, of the strength to fire gunpowder when the spirits are lighted. During the course of twenty-four hours this composition must be repeatedly shook, until the whole appears dissolved; then filter it through blotting paper, and it will be fit to use. In pouring on this ground, an inclination must be given to the plate that the superfluous part of the composition may run off at the opposite side; then place a piece of blotting paper along this extremity, that it may suck up the ground that will drain from the plate, and in the course of a quarter of an hour the spirit will evaporate, and leave a perfect ground that will cover the surface of the copper, hard and dry enough to proceed with. With an exceedingly soft black-lead pencil sketch your design on this ground, and when finished, take a pen and draw with the following composition, resembling ink: if you wish your outline to be thin and delicate, cause the pen you draw with to be made with a sharp point; if you intend to represent chalk drawing, a very soft nib and broad-made pen will be necessary, or a small reed.

No. 2. Composition, resembling ink, to draw the design on copper. Take about one ounce of treacle or sugar-candy, add to this three burnt corks, reduced by the fire to almost an impalpable powder, then add a small quantity of lamp-black to color it; to these put some weak gum-water, (made of gum arabic,) and grind the whole together on a stone with a muller: keep reducing the ink with gum-water until it flows with ease from the pen or reed. To make the ink discharge freely from the pen, it must be scraped rather thin towards the end of the nib, on the back part of the quill, and if the liquid is thick, reduce it with hot water. Having made the drawing on the copper with this composition, you will dry it at the fire until it becomes hard; then varnish the plate all over with turpentine varnish (No. 3). It will now be necessary to let the varnish that is passed over the plate, dry, which will take three or four hours at least; but this will depend on the state of the weather; for if it should be intensely hot, it ought to be left all night to harden. Now the varnish is presumed to be sufficiently hard, you may rub off the touches made with the foregoing described ink with saliva, and use your finger to rub them up; should it not come off very freely, put your walling-wax round the margin of your plate, and then pour on the touches some warm water, but care must be taken it is not too hot. The touches now being clean taken off, wash the plate well and clean from all impurities and sediments of the ink, with cold *soft* water, then dry the plate at a distance from the fire, or else in the sun, and when dry, pour on your aquafortis, which should be in cold weather, as follows:—

To one pint of nitrous acid, or strong aquafortis, add two parts, or twice its quantity of soft water. In hot weather, to one part of nitrous acid add three of water. In every part of this process avoid hard or pump water. The last process of biting in with aquafortis must be closely attended to, brushing off all the bubbles that arise from the action of the aquafortis on the copper.

In summer time it will take about twenty minutes to get a sufficient color: in winter, perhaps, half an hour, or more. All this must depend on the state of the atmosphere and temperature of your room. If any parts require to be stopped out, do the same with turpentine varnish and lamp black, and with a camel-hair brush pass over those parts you consider of sufficient depth; distances and objects receding from the sight of course ought not to be so deep as your fore-grounds; accordingly you will obliterate them with the foregoing varnish, and then let it dry, when you will apply the aquafortis a second time, and repeat this just as often as you wish to procure different degrees of color. Every time you take off the aquafortis the plate must be washed twice with soft water, and then set to dry as before. To ascertain the depth of your work, you should rub a small part with a piece of rag dipped in turpentine, and then apply the finger, or a piece of rag rubbed on the oil-rubber, to the place so cleared, and it will give you some idea of the depth. The walling-wax is taken off by applying a piece of lighted paper to the back of the plate, all round the opposite parts of the margin where the wax is placed, then let the plate cool, and the whole of the grounds, &c., will easily come off by washing the plate with oil of turpentine, which must be used by passing a rag backwards and forwards, until the whole dissolves, it is then to be cleaned off by rags; and care must be taken that no part of the turpentine is left hanging about the plate. The plate should only pass once through the press.

Directions respecting Grounds.—No. 1. The ground in hot weather must have an additional one-third of spirits ot wine added to it, for coarse grounds, to represent chalk; and one-half added to it for fine grounds, to represent black-lead pencil; and, always to be kept in a cold place in summer, and a moderate warm situation in winter.

If any parts are not bit strong enough, the same process is to be repeated. Gum water must be made in the proportion of half an ounce of gum-arabic to a quarter of a pint of water. Turpentine varnish is composed of an ounce of black rosin to an eighth part of a pint of spirits of turpentine; if the weather is excessively warm, it ought to be made with a sixth part of a pint of spirits of turpentine. Tracing rag should be made of a piece of Irish linen, not too much worn, the surface of which is to be rubbed with another rag dipped in sweet oil, just sufficient to retain a small portion of vermilion or pounded red chalk. This must be placed with the colored part towards the ground of the plate, and the drawing or tracing laid upon it, which must be traced very lightly with a blunt point or needle.

* * *

MAKING OF DISTILLED WATERS.

Preservation of flowers for distillation.—Rub three pounds of rose-leaves for two or three minutes with a pound of common salt. The flowers being bruised by the friction of the grains of salt, form a paste which is to be put into an earthen jar, or into a water-tight barrel. The same process is to be repeated until the vessel is filled, so that all the roses may be equally salted. The vessel is then to be shut up and kept in a cool place until wanted.

For distillation, this aromatic paste is, at any season, to be put into the body of the still with twice its weight of water; and when heat is applied, the oil, or essential water, is to be obtained in the common way. Both the oil and water, are in this way produced in greater quantity, than by using the leaves without the salt: besides, the preserved paste will keep its flavor and strength unimpaired for several years.

Other flowers, capable of affording essential oils may also be treated in the above-mentioned way, with economy and advantage: as there is thereby no occasion to carry on a hurried process in the heat of summer, when these are in perfection.

1 Plants and their parts ought to be fresh gathered. When they are collected fresh, such only must be employed; but some are allowed to be used dry, as being easily procurable in this state at all times of the year, through rather more elegant waters might be obtained from them whilst green.

2. Having bruised the subjects a little, pour thereon thrice its quantity of spring water.

This quantity is to be diminished or increased, according as the plants are more or less juicy than ordinary. When fresh and juicy herbs are to be distilled, thrice their weight of water will be fully sufficient, but dry ones require a much larger quantity. In general, there should be so much water, that after all intended to be distilled has come over, there may be liquor enough to prevent the matter from burning to the still.

3. Formerly, some vegetables were slightly fermented with the addition of yeast, previous to the distillation.

4. If any drops of oil swim on the surface of the water, they are to be carefully taken off.

5. That the waters may be kept the better, about one-twentieth part of their weight of proof spirit, may be added to each, after they are distilled.

Stills for simple waters.—The instruments chiefly used in the distillation of simple waters are of two kinds, commonly called the hot still, or alembic, and the cold still. The waters drawn by the cold still from plants are much more fragrant, and more fully impregnated with their virtues, than those drawn by the hot still, or alembic. The method is this:—A pewter body is suspended in the body of the alembic, and the head of the still fitted to the pewter body; into this body the ingredients to be distilled are put, the alembic filled with water, the still-head luted to the pewter body, and the nose luted to the worm of the refrigeratory or worm. The same intention will be answered by putting the ingredients into a glass alembic, and placing it in a bath-heat, or balneum mariæ. The cold still is much the best adapted to draw off the virtues of simples, which are valued for their fine flavor when green, which is subject to be lost in drying; for when we want to extract from plants a spirit so light and volatile, as not to subsist in open air any longer than while the plant continues in its growth, it is certainly the best method to remove the plant from its native soil, into some proper instrument, where, as it dies, these volatile parts can be collected and preserved. And such an instrument is what we call the cold still, where the drying of the plant, or flower, is only forwarded by a moderate warmth, and all that rises is collected and preserved.

Expeditious method of distilling simple waters.—Tie a piece of muslin or gauze over a glazed earthen pot, whose mouth is just large enough to receive the bottom of a warming-pan; on this cloth lay the herb, clipped; then place upon them the warming-pan, with live coals in it, to cause heat just enough to prevent burning, by which means, as the steam issuing out of the herb cannot mount upwards, by reason of the bottom of the pan just fitting the brim of the vessel below it, it must necessarily descend, and collect into water at the bottom of the receiver, and that strongly impregnated with the essential oil, and the salt of the vegetable thus distilled; which, if wanted to make spirituous or compound water, is easily done, by simply adding some good spirits, or French brandy to it, which will keep good for a long time, and be much better than if the spirits had passed through a still, which must, of necessity, waste some of their strength. Care should be taken not to let the fire be too strong, lest it scorch the plants; and to be made of charcoal, for continuance and better regulation, which must be managed by lifting up and laying down the lid, as wanted to increase or decrease the degrees of heat. The deeper the earthen pan, the cooler the season; and the less fire at first (afterwards to be gradually raised), in the greater perfection will the distilled water be obtained.

As the more moveable, or volatile parts of vegetables, are the aqueous, the oily, the gummy, the resinous, and the saline, these are to be expected in the waters of this process; the heat here employed being so great as to burst the vessels of the plants, some of which contain so large a quantity of oil, that it may be seen swimming on the surface of the water. Although a small quantity only of distilled waters can be obtained at a time by this confined operation, yet it compensates in strength what is deficient in quantity. Such liquors, if well corked up from the air, will keep good a long time, especially if about a twentieth part of any spirits be added, in order to preserve the same more effectually.

(To be continued

OF FRICTION.

If a horizontal plane were *perfectly* smooth, a body would be free to move upon it in any direction by the least force applied to it. But however smooth bodies may appear to the eye, numberless inequalities are discoverable by means of the microscope; in consequence of which the protruding parts of one body fall into the cavities of the other, and so become locked together; thus rendering necessary the application of a new force to raise the prominent parts of the one from the hollows of the other. This is what is called *friction.*

Friction is greater in bodies, in proportion to their weight or pressure against each other. It also increases in proportion to the velocity of the moving bodies.

A piece of smooth soft wood, eight pounds in weight, moving upon a smooth plane of soft wood, at the rate of three feet every second, has a friction equal to above two-thirds of its weight. Soft wood upon hard wood has a friction equal to one-sixth part of its weight; and hard wood upon hard wood, about one-eighth part of its weight.

In wood rubbing upon wood, oil, grease, or black-lead, properly applied, makes the friction two-thirds less.

When polished steel moves on steel, or pewter properly oiled, the friction is about one-fourth of its weight—on copper or lead, one-fifth; on brass, one-sixth. Metals have more friction, when they move on metals of the same kind, then when on different metals.

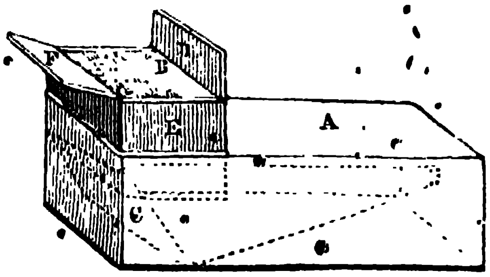
The friction of the wheel and axle is in proportion to the weight, velocity, and diameter of the axle. The smaller the diameter the less the friction.

In the wedge and screw the friction is great. Screws with sharp threads have more than those with square threads, and endless screws have more thon either.

IMPROVED CAMERA OBSCURA.

(To the Editor.)

Sir,—I take the liberty of forwarding to you an improvement I have made in the portable camera obscura; the following cut will assist my intention:—Let the usual pieces of wood which are placed on the side of the flap, which shades the glass plate or field of view be taken away, and the box E, without top, bottom, or one side be substituted; if this be made to slide up and down in the sockets that the two pieces of wood slide in, and the ground glass be put on two ledges at the top of the box, the focus may be arranged sufficiently clear, to be able to take portraits by the photogenic apparatus; I have done so, and find the pictures very distinct. In the figure, A is the camera, B the ground glass, C the reflector, D the flap, without the pieces of wood, E the box, and F the flap, to shut down to keep off the light; the box is to be pulled up and down, till the exact focus is arranged. Hoping you will find a place in your columns for this, I remain, Sir, &c.,



EDWARD P.

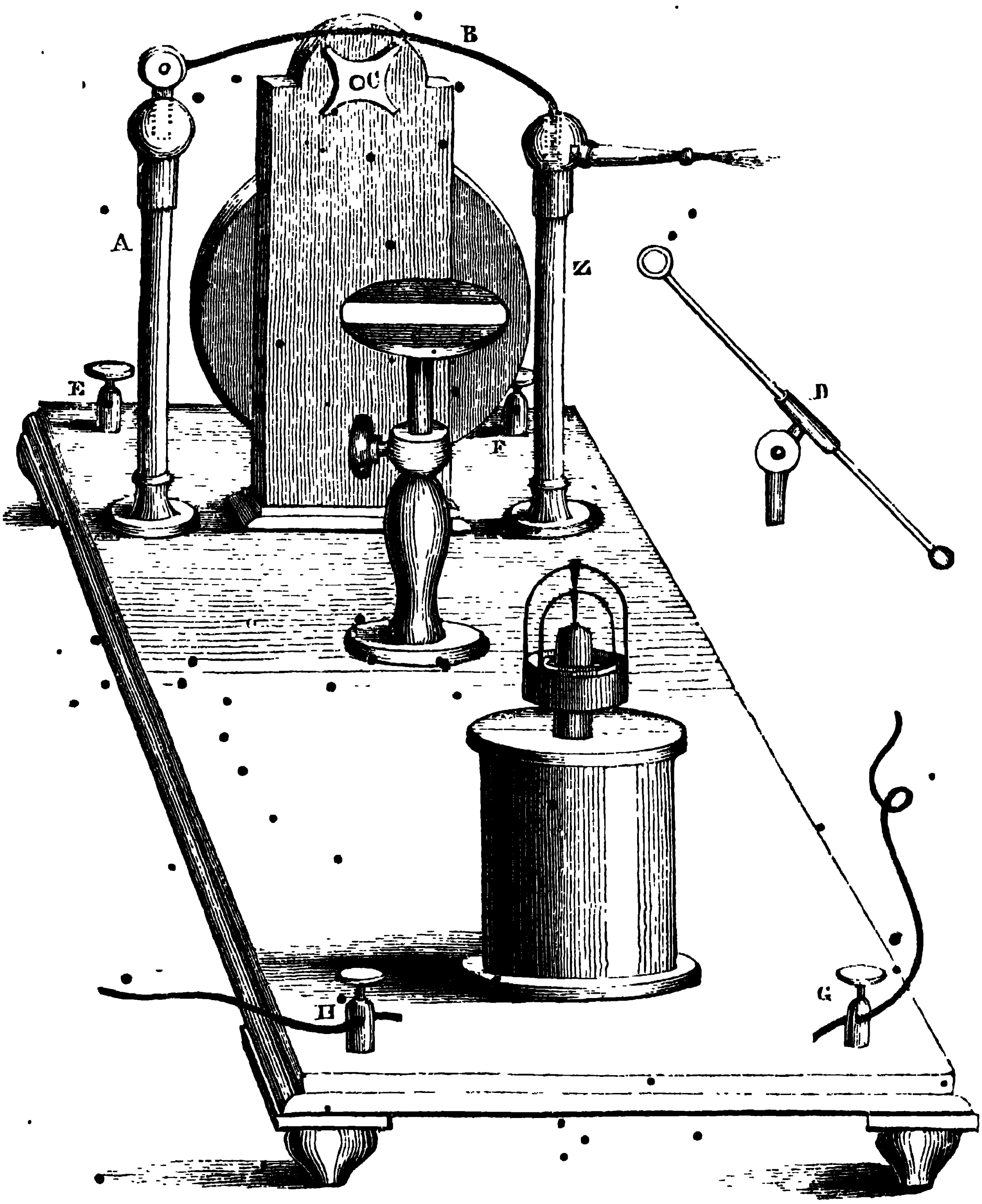
MEMORANDA.

Animal Electricity.—Mr. Glover has published the following method of receiving the electrical shock from a cat. Place the left hand under the throat; with the middle finger and the thumb slightly pressing the bones of the animal's shoulder, then gently passing the right hand along the back, sensible electrical shocks will be felt in the left hand. Very distinct discharges may be obtained, too, by touching the tips of the ears after applying friction to the back of the cat. It will be hardly necessary, we suppose, to hint how requisite that a good understanding should exist between the experimenter and the *apparatus*, lest shocks might be elicited more electric than were to be wished.

Atmospherical or Meteoric Dust.—Professor Rafenesque, of NewYork, asserts, that an imperceptible dust falls at all times from the atmosphere, and that he has seen it on Mount Etna, on the Alps, on the Alleghany and Catskill mountains in America, and also on the ocean. This is the same dust, he asserts, which accumulates in our apartments, and renders itself peculiarly visible in the beams of the sun. He has found it to accumulate at the rate of one fourth of an inch to one inch in a year; but in such a fleecy state, that it could be compressed to one-third of its height. Hence he takes the average of the yearly deposit at about one-sixth of an inch.

Composition of the Bronze of the Ancients.—It appears, from a number of experiments, that the bronze, of which the ancients formed their weapons, and other articles, consists of 88 parts of copper to 12 of tin; and it is remarkable that the same admixture of the metals has been employed in nations very remote from each other.

To Whiten Discolored Pearls.—Soak them in hot water, in which some bran with a little tartar and alum have been boiled; rub them gently between the hands, which may be continued until the water grows cold, or until the object is effected, when they may be rinced in lukewarm water, and laid on writing paper in a *dark* place to cool.



SKIPSEY'S ELECTRO-MAGNETIC ENGINE.

ELECTRO-MAGNETIC ENGINE.

(To the Editor.)

SIR.—I send you an account of a very convenient electro-magnetic engine, which I have constructed for my own use: it does not differ in principle from that of Mr. Bachhoffner, which you described in your first volume, nor yet from others since inserted in your valuable Magazine, but it is more convenient than they are, on account of the facility of attaching the usual electro-magnetic apparatus to it, especially by the introduction of the universal discharger.—It is as follows.—

Z A, are two brass pillars, with holes drilled on top of each for the brass wire B. C, a cam or break with pulley on back of an upright pillar Z, with mercury in hole at top to break connection; to use the table, take out the wire B, then put two wires and joints, like D, into the holes of A and Z, with the table between them. This table you may show many experiments on. The machine altogether answers very well; it requires a large coil of primary wire to make the iron bar a strong magnet to cause the buckets to rotate; one end of the primary coil goes to the pillar with mercury on the top end of it at Z, the other end goes to the binding screw E. There is a wire soldered to pillar A and goes to binding screw F; one end of the secondary coil goes to binding screw G, the other end goes to binding screw H. Put a little powder on the top of pillar Z, turn the multiplying wheel, and it will fire the powder instantly; likewise on the table, if the two wires be put in the place of the brass wire B. The pillar Z has a small cannon screwed in near the top, with touch-hole at the end, about $\frac{1}{8}$ of an inch above the mercury; to fire the cannon, put a little gunpowder on the top of the mercury, then turn the multiplying wheel, and the cannon goes off. The brass wire B must work clear in the hole on top of the pillar Z, not to touch the pillar any where only on the top of the mercury. If you think the above worth your notice, the insertion will oblige, yours,

Mile Gate, Ripon W. SKIPSEY.

MICROSCOPIC OBJECTS.

WE have repeatedly been referred to for a list of microscopic objects, such as will at once show the powers of an instrument, yield instruction and amusement, and yet such, that amateurs in the country may procure and mount them for their own use. We have somewhat neglected this subject lately, because we often adverted to it in the first volume, but the description of a microscope in our last part has again drawn upon us several inquiries; we shall best answer them, by referring our readers to an excellent little work, entitled "A List of Two Thousand Microscopic Objects," by Mr. Pritchard, the well-known author of several works on infusorial animals, and a celebrated maker of microscopes in Fleet Street. We have carefully looked over the list, (which is published at *a shilling* only,) and are obliged to testify to the choice selection of objects, as well as the other interesting matter which it contains on mounting, collecting, &c. To show the nature of the introductory remarks, we take the following almost at random:—

"The eggs of birds are oval, but those of insects assume a vast variety of forms: some are furnished with covers: the surfaces of many are elegantly embossed or fluted, whilst others, as those of the Bug (*Cimex lectularius*,) have their surface curiously granulated. Those given in the list will be found among the most interesting for microscopic observation. They require in most cases to be viewed by reflected light, and with moderate amplification; namely, between 20 and 60.

"*Human Hair.*—In the adult, the friction of the hairs against each other is such, that their exterior structure is seen with difficulty. From a consideration of this circumstance, and finding the hairs of infants frequently matted, or felted together in small knots, after washing, arising from its jagged surface, I was induced to examine the latter, and finding the asperities much more decided than in that from the adult, I procured some specimens from a babe only two hours old, in which the imbricated structure was very distinct. On mounting, however, a specimen of this hair in Canada balsam, the exterior characters were obliterated.

"*Hair of Caterpillars.*—The hairs of some species, when examined by the microscope, resemble branches of the black thorn; and others are formed with branches on each side, like a fan, resembling the feathers of the peacock's tail.

"Butterflies, moths, and many other insects, are covered with scales or feathers, overlapping each other like the tiles of a house. They vary greatly in form and size, and from the difficulty with which the structure of many of them is developed by the microscope, they become excellent tests of its penetrating power. In the list, I have introduced the most interesting and peculiar, and it may be observed that such are seldom found on the *red* parts of the wing; the white or blue yield the greatest variety.

"If the crystalline lens in the eye of a fish be minutely examined by the aid of the microscope, it will be found to be composed of a number of concentric strata or layers, somewhat resembling the coats of an onion. One of these laminæ, separated, and placed under a powerful microscope, will be seen to consist of flat fibres or bands, arising from each pole of the globular lens, and expanding towards the equator, like the spaces between the meridians on the artificial globe. The edges of these fibres are serrated, and fit into each other like the teeth of a double rack, or the sutures of the human skull. Sir David Brewster, who first minutely examined the structure of these lenses, has accurately measured the width of the bands. (See *Phil. Trans.* 1833.) He found a single lens, four-tenths of an inch in diameter, from the eye of a cod, contained five millions of these flat fibres, and 62,500 millions of serratures or teeth. Whether as opaque or as transparent objects, I have been much delighted with them. Viewed as the former, an amplification of 250 times is sufficient, but as the latter, 400 times linear may be employed with advantage.

"The method of mounting in alcohol or spirit of wine is as follows:—Take a slip of glass, and cover it on one side with a coat of painters' whitelead, leaving a space in the middle large enough to contain the object to be mounted;—when this coat is dry, add another, and proceed thus until a sufficient thickness is obtained for the inclosure of the object to be mounted. The next thing is to procure a clear piece of mica, free from veins and flaws, and rather smaller than the slip of glass. Fill the cavity above referred to with spirit of wine, place the object therein, and cover it with a plate of mica, which must be brought into close contact with the white-lead, by gently pressing it with a smooth piece of wood from one extremity to the other, so as perfectly to expel the air-bubbles. In a few days the white-lead will have become hard, and if the mica be sound, the inclosed specimen may be preserved for years. In plants it must be remembered that excepting their elementary tissues, much of their delicacy is destroyed by this method of mounting, although in many cases it is still highly desirable.

"The most interesting active phenomenon exhibited by the microscope is the circulation of the nutritious fluids in animals and plants. In the former, the globules of blood may be seen passing rapidly along the capillary ends of the arteries into those of the veins, when the intervening membrane is sufficiently diaphanous, as in the ear of the young mouse; the fins and tail of the carp, gold-fish, stickleback, tadpole, and of most small fish; and in the web between the toes of the frog, lizard, eft, &c. For these purposes, a magnifying power from 100 to 250 times linear is sufficient.

"In the Arachnoida (Spider tribe,) at the joints of the legs, I have observed the circulation very distinct, the current of dark globules passing rapidly at each pulsation of the dorsal vessel. In the antennæ and wings of terrestrial insects, it has also been seen when they have just emerged from the chrysalis, as in the Perla viridis and Semblis bilineata. In several aquatic larvæ and small crustacea, the circulating fluid traverses the limbs, antennæ, and tail, and thence moves along the dorsal vessel towards the head, and down the sides of the body, in cavities, and not distinct vessels; hence called *diffused* circulation. The most favorable subjects for viewing this are the following:—Larva of the ephemera. (The recent discovery of the beautiful mechanism of the dorsal vessel of this larva by Mr. Bowerbank is fully confirmed by the careful dissections of Mr. Newport, who, with much perseverance, has extended these inquiries to the other states of insects.) Larva of hydrophilus; small dytiscus; agrion puella. (In this elegant larva I have not observed the circulation in the legs to extend beyond the haunches.) Libellula; round lynceus; fresh-water shrimp; water hog (Oniscus); Ligia; water flea (daphnia pulex); &c. Power 100 to 300 times.

"In several of the polypiferous zoophytes, as the tubularia indivisa, sertulariæ, campanulariæ, plumulariæ, &c. Mr. Lister has, by means of the achromatic engiscope, discovered a circulation to exist, which in many respects resembles that in plants.—See *Phil. Trans.*

"The circulation in plants termed *cyclosis* is a revolution of the fluid contained in each cellule, and is distinct from those surrounding it. It can be observed in all plants in which the circulating fluid contains particles of a different refractive power or intensity, and the cellules of sufficient size and transparency. Hence all lactescent plants, or those having a milky juice, with the other conditions, exhibit this phenomenon. The following aquatic plants are generally transparent enough to show the circulation in every part of them:—Nitella hyalina; nitella translucens; chara vulgaris; and caulinia frigalis. In the frog-bit (hydrocharis) it is best seen in the stipulæ of the leaves and the ends of the roots. The magnifying power suited for the above are between 100 and 250 times linear. In the spider-wort (tradescantia virginica) it is seen in the filaments surrounding the stamens of the flower: power 300 to 500 times linear. In the common groundsel (senecio vulgaris) it is said to be seen in the hairs surrounding the stalks and flowers. In the valisneria spiralis circulation may be seen in sections of the leaf."

ETCHING AND DYEING FIGURES ON IVORY.

BY J. CATHERY.

THE usual mode of ornamenting ivory in black is to engrave the pattern or design, and then to fill up the cavities thus produced with hard black varnish. The demand for engraved ivory in ornamental inlaying, and for other purposes, is considerable, although the price paid for it is not such as to encourage artists of much ability to devote themselves to this work, which consequently is trivial in design and coarse in execution. Mr. Cathery's improvement consists in covering the ivory with engraver's varnish, and drawing the design with an etching needle; he then pours on a menstruum composed of one hundred and twenty grains of fine silver, dissolved in one ounce measure of nitric acid, and then diluted with one quart of pure distilled water. After half an hour, more or less, according to the required depth of tint, the liquor is to be poured off, and the surface is to be washed with distilled water, and dried with blotting paper; it is then to be exposed to the light for an hour, after which the varnish may be removed by means of oil of turpentine. The design will now appear permanently impressed on the ivory, and of a black or blackish brown color, which will come to its full tint after exposure for a day or two to the light.

The property which nitrate of silver possesses, of giving a permanent dark stain to ivory and many other substances has been long known; but Mr. Cathery has the merit of having advantageously applied it in a department of art in which it is likely to be of considerable service, by improving the quality of the ornament, and at the same time of diminishing the cost. Varieties of color may also be given by substituting the salts of gold, platina, copper, &c., for the solution of silver.

EARTHQUAKES.

AN earthquake consists of a violent agitation of the earth, accompanied by various other phenomena more or less singular and destructive in their effects, but by no means uniform in character, as the following enumeration of concomitant circumstances, gleaned from the accounts of various earthquakes that have occurred in ancient and modern times, will sufficiently evince. Earthquakes are usually preceded by a general stillness in the air, and an unnatural agitation of the waters of the ocean and of lakes. The shock comes on with a deep rumbling noise, like that of a carriage over a rough pavement, or with a tremendous explosion resembling a discharge of artillery, or the bursting of a thunder cloud; and sometimes heaves the ground perpendicularly upwards, and sometimes rolls it from side to side. The single shocks of an earthquake seldom last longer than a minute, but they frequently follow one another at short intervals for a considerable length of time. During these shocks large chasms are made in the ground, from which sometimes smoke and flames, but more frequently stones and torrents of water, are discharged. In violent earthquakes, these chasms are sometimes so extensive as to overwhelm whole cities at once. In consequence of these shocks, also, whole islands are frequently sunk and new ones raised; the course of rivers is changed; seas overflow the land, forming gulfs, bays, and straits; sometimes disrupting the land into islands, and sometimes joining them to the continent.

There is no portion of the earth's surface, whether it be land or water, that is not more or less subject to earthquakes; and records of their destructive effects have been transmitted to us through every age. The first earthquake particularly worthy of notice was that which, in A.D. 63, destroyed Herculaneum and Pompeii. In the fourth and fifth centuries, some of the most civilized parts of the world were almost desolated by these awful visitations. Thrace, Syria, and Asia Minor, according to contemporary historians, suffered most severely. On the 26th of January, A.D. 447, subterranean thunders were heard from the Black to the Red Sea, and the earth was convulsed, without intermission, for the space of six months; and in Phrygia, many cities and large tracts of ground were swallowed up. On the 30th of May, A.D. 205, the city of Antioch was overwhelmed by a dreadful earthquake, and 250,000 of its inhabitants are said to have been crushed in its ruins.

In the year 1346, Asia Minor and Egypt were violently shaken; and in the following year severe earthquakes were experienced in Cyprus, Greece, and Italy.

In 1692, the island of Jamaica was visited by a terrible earthquake, in which enormous masses of earth were detached from the Blue Mountains; and vast quantities of timber, hurled from their flanks, covered the adjacent sea, like floating islands. It was during this earthquake that the city of Port Royal, with a large tract of adjacent land, sunk instantaneously into the sea. In the following year great earthquakes occurred in Sicily, which destroyed Catania and 140 other towns and villages, with 100,000 of their inhabitants.

Since the records of history, there have been no earthquakes equal in intensity to those which ravaged different parts of the world in the eighteenth century. Passing over the convulsion which in 1746 nearly laid waste Lower Peru, and those by which in 1750 the ancient town of Concepcion in Chili was totally destroyed, we come to 1755, when the city of Lisbon was almost wholly destroyed by one of the most destructive earthquakes which ever occurred in Europe. It continued only six minutes; but such was the violence of the convulsion, that in that short space upwards of 60,000 persons are said to have perished. The phenomena that accompanied it were no less striking. The sea first retired and laid the bar dry; it then rolled in, rising fifty feet or more above its ordinary level. The largest mountains in Portugal were impetuously shaken from their very foundations; and some of them opened at their summits, which were split and rent in a wonderful manner, huge masses of them being thrown down into the subjacent valleys. But the most remarkable circumstance which occurred at Lisbon during this catastrophe was the entire subsidence of the new quay, called Cays de Prada, to which an immense concourse of people had fled for safety from the falling ruins. From this hideous abyss, into which the quay sunk, not one of the dead bodies ever floated to the surface; and on the spot there is now water to the depth of 100 fathoms. This earthquake excited great attention from the incredibly great extent at which contemporary shocks were experienced. The violence of the shocks, which were accompanied by a terrific subterranean noise, like the loudest thunder, was chiefly felt in Portugal, Spain, and northern Africa; but the effects of the earthquake were perceived in almost all the countries of continental Europe, and were even experienced in the West Indies, and on the Lake Ontario in North America. Ships at sea were affected by the shocks as if they had struck on rocks; and even at some of the Scottish lakes, Loch Lomond in particular, the water, without the least apparent cause, rose to the perpendicular height of two feet four inches against its banks, and then subsided below its usual level. During the next twenty years, various earthquakes occurred in different parts of the world, attended with more or less destructive consequences. In 1759, Syria was agitated by violent earthquakes, the shocks of which were protracted for three months, throughout a space of 10,000 square leagues, and levelled to the gronnd Accon, Saphat, Balbeck, Damascus, Sidon, Tripoli, and many other places. In each of these places many thousands of the inhabitants perished; and in the valley of Balbeck alone, 20,000 men are said to have been victims to the convulsion. In 1766, the island of Trinidad and great part of Columbia were violently agitated by earthquakes. In 1772, the lofty volcano of Papandayang, the highest mountain in Java, disappeared, and a circumjacent area, fifteen miles by six, was swallowed up. In 1783, the north-eastern part of Sicily and the southern portion of Calabria were convulsed by violent and oft-repeated shocks, which overthrew the town of Messina, and killed many thousands of its inhabitants, as well as many persons in Calabria. In the same year the islands of Japan, Java in 1786, Sicily and the Caraccas in 1790, Quebec in 1791, and the Antilles and Peru in 1797, were violently agitated by convulsions of this kind.

Since the commencement of the present century, various earthquakes have occurred both in the Old and New World. In 1811, violent earthquakes shook the valley of the Mississippi, by which lakes of considerable extent disappeared, and new ones were formed. In 1812, Caraccas was destroyed, and upwards of 12,000 of its inhabitants buried in the ruins. In 1815 the town of Tombora, in the island of Sumbawa, was completely destroyed by an earthquake, which extended throughout an area 100 miles in diameter, and destroyed 12,000 persons. In 1819, a violent earthquake occurred at Cutch, in the Delta of the Indus, by which, among other disastrous consequences, the principal town, Bhoog, was converted into a heap of ruins. In 1822, Aleppo was destroyed by an earthquake. In the same year Chili was visited by a most destructive earthquake, from which the coast for 100 miles is stated to have sustained an elevation of from two to four feet, while about a mile inland from Valparaiso, it was raised from six to seven feet. In 1827, Popayan and Bogota suffered severely from earthquakes, during which vast fissures opened in the elevated plains around the latter city. In 1835, the town of Concepcion, in Chili, was entirely demolished by an earthquake. In 1837, the countries along the eastern extremity of the Mediterranean, especially Syria, were violently agitated by an earthquake, which caused great damage to the towns of Damascus, Acre, Tyre, and Sidon, and entirely destroyed Tiberias and Safet. Such are some of the most violent earthquakes that have occurred within the period of authentic history. The reader will find in *Poggendorf's Annalen* lists of the different earthquakes that have taken place within the last twenty years; and from these it will be observed that scarcely a month elapses without being signalized by one or many convulsions in some part of the globe. Shocks of earthquakes have at different times been felt in various parts of Britain, and more particularly in Scotland; but they have all fortunately been so insignificant, compared to those which have been experienced in other countries, that we shall refrain from entering into any details respecting them.

But though history supplies us with so large a catalogue of well-authenticated earthquakes, it is surprising that so little was done by the ancients either in investigating their causes or noticing their effects. It is only within the last century and a half, says Mr. Lyell, since Hooke first promulgated his views respecting the connection between geological phenomena and earthquakes, that the permanent changes effected by these convulsions have excited attention. Before that time the narrative of the historian was almost exclusively confined to the number of human beings who perished, the number of cities laid in ruins, the value of property destroyed, or certain atmospheric appearances which dazzled or terrified the observers. The creation of a new lake, the engulphing of a city, or the raising of a new island, are sometimes, it is true, adverted to, as being too obvious or of too much geographical interest to be passed over in silence. But no researches were made expressly with the view of ascertaining the amount of depression or elevation of the ground, or any particular alterations in the relative position of sea and land; and very little distinction was made between the raising of soil by volcanic ejections, and the upheaving of it by forces acting below. The same remark applies to a very large proportion of modern accounts; and how much reason we have to regret this deficiency of information appears from this, that in every instance where a spirit of scientific inquiry has animated the eye-witnesses of these events, facts calculated to throw light on former modifications of the earth's structure are recorded.

MAKING OF DISTILLED WATERS.

(Resumed from page 400, and concluded.)

To make rosemary water.—As the method of performing the operation by the cold still is the very same, whatever plant or flower is used, the following instance of procuring a water from rosemary, will be abundantly sufficient to instruct the young practitioner in the manner of conducting the process in all cases whatever. Take rosemary, fresh gathered in its perfection, with the morning dew upon it, and lay it lightly and unbruised upon the plate or bottom of the still; cover the plate with its conical head, and apply a glass receiver to the nose of it. Make a small fire of charcoal under the plate, continuing it as long as any liquor comes over into the receiver. When nothing more comes over, take off the still head, and remove the plant, putting fresh in its stead, and proceed as before; continue to repeat the operation successively, till a sufficient quantity of water is procured. Let this distilled water be kept at rest in clean bottles, close stopped, for some days in a cold place; by this means it will become limpid, and powerfully impregnated with the taste and smell of the plant.

Simple pennyroyal water.—Take of pennyroyal leaves, dry, a pound and a half; water as much as will prevent burning. Drawing off by distillation while scent continues.

Simple spearmint water.—Take of spearmint leaves, fresh, any quantity; water, three times as much. Distil as long as the liquor which comes over has a considerable taste or smell of the mint. Or, take spearmint leaves, dried, 1¼ lbs., water, as much as is sufficient to prevent burning. Draw off by distillation 1 gallon.

Cinnamon water.—Take of bruised cinnamon, 1 lb., water, 2 gallons. Simmer in a still for half an hour, put what comes over into the still again; when cold, strain through flannel.

Eau sans-pareil.—Take two gallons of fine old honey-water, put it into a still capable of holding four gallons, and add the thinly pared rinds of six or eight fresh citrons, neither *green* nor *mellow* ripe. Then add sixty or seventy drops of fine Roman bergamot; and, having luted the apparatus well, let the whole digest in a moderate heat for twenty-four hours. Draw off, by a water-bath heat, about one gallon.

Jessamine water.—Take six pounds of the white sweet almond cakes, from which jessamine oil has been made abroad; beat and sift them to a fine powder, and put to it as much fresh oil of jessamine as will be required to make it into a stiff paste. Let this paste be dissolved in about six quarts of spring water, which has been previously well boiled, and left until it has become about half cold. Stir and mix the whole well together; and when the oil and water has been well combined, let the whole stand until the powder has fallen to the bottom of the vessel. Now pour the liquid off gently, and filter it through cotton, in a large tin funnel, into the glass bottle in which it is to be kept for use. The powder or sediment which has been left at the bottom of the vessel, when dried by the heat of the sun, answers very well for making almond-paste for the hands.

Myrtle water.—Infuse eight or ten lbs. of the cuttings of green myrtle, in nearly twenty gallons of rain or river water, and add thereto a pint of fresh yeast, after it has stood for twenty-four hours. At the end of another day and night, put the whole into a still, with a pound of bay salt. Draw off the whole of the water; and, next day, infuse more myrtle leaves, as before, and distil again. Repeat the same a third time.

Orange flower water.—Take two lbs. of orange flowers, and twenty-four quarts of water, and draw over three pints. Or, take twelve lbs. of orange flowers, and sixteen quarts of water, and draw over fifteen quarts.

Orange peel water.—Take of the outward yellow rind of Seville oranges, four ounces; water, three gallons and a half; draw off one gallon by the still, with a brisk fire.

Peppermint water.—Take of the herb of peppermint, dried, 1½ lbs., and of water, as much as is sufficient to prevent burning: distil off a gallon. This has been known to allay sickness when nothing else would succeed, and is used in flatulent colics. A wine-glassful may be taken, and often repeated.

Another. Take of oil of peppermint, one lb., water a sufficient quantity. Draw off thirty gallons. This is stimulant and carminative; and covers disagreeable flavors.

Portugal and angel waters.—Take a pint of orange-flower water, a pint of rose-water, and half a pint of myrtle-water; to these put a quarter of an ounce of distilled spirit of musk, and an ounce of spirit of ambergris. Shake the whole well together, and the process will be finished

Rose water.—Take of the leaves of fresh damask roses with the heels cut off, six lbs., water, as much as to prevent burning. Distil off a gallon.

To make any distilled waters.—As all distilled waters consist merely of water impregnated with the essential oil of herbs, they may be promptly made by purchasing the essential oil at any chemists.

Then triturate oil in a mortar, say ½ an oz., with a ¼ lb. of sugar, or some magnesia, and mingle with water to your fancy. The distilled waters should be drawn from dried herbs, because the fresh cannot be got at all times in the year. Whenever the fresh are used the weights must be increased; but whether the fresh or dry are made use of, it is left to the judgment of the operator to vary the weight, according as the plants are in greater or less perfection, owing to the season in which they grew, or were collected.

TO MANUFACTURE REAL MOROCCO LEATHER.

The skins being first dried in the air, are steeped in water three days and nights; then stretched on a tanner's horse, beaten with a large knife, and steeped afresh in water every day: they are then thrown into a large vat on the ground, full of water, where quicklime has been slacked, and there lie fifteen days; whence they are taken, and again returned every night and morning. They are next thrown into a fresh vat of lime and water, and shifted night and morning for fifteen days longer; then rinsed in clean water, and the hair taken off on the leg with the knife, returned into a third vat, and shifted as before for eighteen days; steeped twelve hours in a river, taken out, rinsed, put in pails, where they are pounded with wooden pestles, changing the water twice; then laid on the horse, and the flesh taken off; returned into pails of new water, taken out, and the hair-side scraped; returned into fresh pails, taken out, and thrown into a pail of a particular form, having holes at bottom: here they are beaten for the space of an hour, and fresh water poured on from time to time; then being stretched on the leg, and scraped on either side, they are returned into pails of fresh water, taken out, stretched, and sewed up all round, in the manner of bags, leaving out the hinder legs, as an aperture for the conveyance of a mixture described below.

The skins thus sewed are put in lake-warm water, where dogs' excrements have been dissolved. Here they are stirred with long poles for half an hour, left at rest for twelve hours, taken out, rinsed in fresh water, and filled by a funnel with a preparation of water and sumach, mixed and heated over the fire till ready to boil; and, as they are filled, the hind legs are sewed up to stop the passage. In this state they are let down into the vessel of water and sumach, and kept stirring for four hours successively; taken out and heaped on one another: after a little time their sides are changed, and thus they continue an hour and a half till drained. This done, they are loosened, and filled a second time with the same preparation, sewed up again, and kept stirring two hours, piled up and drained as before. The process is again repeated with this difference, that they are then only stirred a quarter of an hour; after which they are left till next morning, when they are taken out, drained on a rack, unsewed, the sumach taken out, folded in two from head to tail, the hair-side outwards, laid over each other on the leg, to perfect their draining, stretched out and dried: then trampled under foot by two and two, stretched on a wooden table, what flesh and sumach remains scraped off, the hair-side rubbed over with oil, and that again with water.

They are then rung with the hands, stretched, and pressed tight on the table with an iron instrument like that of a currier, the flesh-side uppermost; then turned, and the hair-side rubbed strongly over with a handful of rushes, to squeeze out as much of the oil remaining as possible. The first coat of *black* is now laid on the hair-side, by means of a lock of hair twisted and steeped in a kind of black dye, prepared of sour beer, wherein pieces of old rusty iron have been thrown. When half-dried in the air, they are stretched on a table, rubbed over every way with a paumelle, or wooden-toothed instrument, to raise the grain, over which is passed a light couche of water, then sleeked by rubbing them with rushes prepared for the purpose. Thus sleeked, they have a second couche of black, then dried, laid on the table, rubbed over with a paumelle of cork, to raise the grain again; and, after a light couche of water, sleeked over anew; and to raise the grain a third time, a paumelle of wood is used.

After the hair-side has received all its preparations, the flesh side is pared with a sharp knife for the purpose; the hair-side is strongly rubbed over with a woollen cap, having before given it a gloss with barberries, citron, or orange. The whole is finished by raising the grain lightly, or the last time, with the paumelle of cork; so that they are now fit for the market.

To prepare Red Morocco.—After steeping, stretching, scraping, beating, and rinsing the skins, as before, they are at length wrung, stretched on the leg, and passed after each other into water where alum has been dissolved. Thus alumed, they are left to drain till morning, then wrung out, pulled on the leg, and folded from head to tail, the flesh inwards.

In this state they receive their first dye, by passing them after one another into a red liquor, described hereafter. This is repeated again and again, till the skins have got their first color; then they are rinsed in clean water, stretched on the leg, and left to drain twelve hours; thrown into water through a sieve, and stirred incessantly for a day with long poles; taken out, hung on a bar across the water all night, white against red, and red against white, and in the morning the water stirred up, and the skins returned into it for twenty-four hours

Ingredients for the Red Color.—The following is the quantity and proportions of the ingredients required for the red color, for a parcel of thirty-six skins:—Cochineal, 130 drachms; round suchet, (*crocus indicus,*) 45 drachms; gutta-gamba, 15 drachms; white alum pulverised, 10 drachms; bark of the pomegranate tree, 10 drachms; citron juice, 2 drachms; and common water, 120 pounds. The alum is gradually added to the other articles, and boiled in a copper for about two hours, till one-tenth part of the water be consumed.

FULMINATING COMPOUNDS.

(*Resumed from page 392, and concluded.*)

Pour 2 drams of sulphuric acid into a gallipot, and throw into it 4 grains of chlorate of potass, and 1 grain of phosphorus, divided into minute particles. Here, in addition to the explosion, a very brilliant inflammation will take place. In this, and the two following experiments, the combustible materials should be gently mixed with a wooden skewer in the spoon, from which they are to be thrown into the acid.

Throw, from the point of a knife, three or four grains of chlorate of silver on red-hot charcoal; deflagration will be the consequence, and the silver will be reduced to a metallic state on the charcoal.

Place upon an anvil 2 grains of chlorate of potass and 2 grains of pulverised arsenic, and strike them smartly with a polished hammer; a very loud explosion, attended by a flash of light, will be the consequence. Here the intensity of heat causes combustion of the metal.

(As only a small quantity of this powder should be prepared at one time, the constituents should be kept in separate phials, and mixed as occasion may require.) Mix together 5 drams of the chlorate of potass and 5 drams of pulverised arsenic (the metal) very gently on paper, with a quill or pointed stick, and fire it with a very long match; a very vivid and sudden combustion will take place. If confined, the combustion will be attended by a loud report. In this compound, the arsenic is the principal combustible.

Mix gently in a tea-spoon 3 grains of chlorate of potass and 3 grains of pulverised arsenic (the metal): throw the mixture into a gallipot containing 2 drams of sulphuric acid; instant deflagration will take place.

Prepare a solution of nitrate of ammonia in a very clean jar, so that about one half shall be filled: let this solution be of the temperature of 45° Fahr. Now pass into the jar some chlorine gas from a retort containing 1 ounce of oxide of manganese and 2 ounces of muriatic acid. The gas will be absorbed almost as rapidly as it ascends, and presently the top of the solution will be covered by a film, which collecting into yellow globules, will fall to the bottom. This is the chloride of azote, the most explosive body with which we are acquainted; it is indeed so much so, that great danger is to be apprehended from the employment of more than a globule of the size of a pin's head, in the performance of experiments. This substance should never be touched by any thing which has the least particle of grease or oil on it (except for experiment) as it explodes in an instant, and may do much mischief; —several eminent chemists have been seriously wounded by it. It is best not to make more at one time than is wanted for present experiment.

Put a particle of chloride of azote, of the size of a pin's head, into an iron-spoon tied to the end of a long-stick; hold the spoon over a lamp or fire for a few seconds; the chloride will explode with a very loud report.

Put half a grain of chloride of azote into a very clean small delft basin, and pour upon it (from a spoon tied to the end of a long stick) a few drops of olive, almond, or any essential oil. The instant the oil falls, a tremendous explosion will take place: the basin will be shattered into pieces.

If half a grain of chloride of azote be put gently on half a sheet of clean writing-paper, and a grain of phosphorus (stuck on the sharpened end of a wire, about a yard long) be brought into contact with it, a most violent explosion will instantly take place. This experiment has been performed in a soup-plate; and the quantities used were 1 grain of each substance. The explosion was so violent as to shatter the plate into a thousand pieces. It is very dangerous to use more than the quantities here mentioned; and particularly so, if the vessel in which the experiment is performed be dirty or greasy. It is proper to put the hand before the eyes whilst this explosion takes place, to prevent the phosphorus from entering them.

If 6 grains of charcoal, in powder, be gently mixed with 6 grains of iodate of potass, and laid (folded in a small piece of paper) on an anvil; a smart blow from a hammer, will cause a loud detonation.

Into distilled water fully saturated with ammoniacal gas, put some iodine, as long as a dark powder falls down: pour off the liquor gently—(this liquor is a solution of hydriodic acid, and may be preserved for experiment)—and preserve the powder: this powder is the iodide of azote; the other portion of the iodine having combined with the hydrogen of the ammonia forming hydriodic acid. This powder will detonate by the least heat or friction.

Agitate some liquid chloriodic acid in a phial containing chlorine gas: as the absorption proceeds, the liquid will be rendered colorless. If this colorless liquid be poured into pure liquid ammonia, a white powder will be precipitated, which detonates by the gentlest heat or friction.

Put 10 grains of pure silver into a Florence flask, and pour over it half an ounce of nitric acid, with half an ounce of distilled water; when nearly dissolved, put it over a lamp, and then pour in half an ounce of alcohol; when it has received considerable heat, a white heavy powder will fall to the bottom. When this precipitation ceases, agitate the whole gently, and pour it on a filter; wash out any residuum with warm water; and pour this also on the filter; continue to pour distilled water over the powder until it runs through quite tasteless. Now dry the powder in a watch-glass or wide-mouthed phial by a gentle heat; and when any is wanted for experiment, take it out with a small wooden spatula.

Wrap a grain of detonating silver in a small piece of paper, place it on the floor, and press upon it with the heel; a brisk explosion, with slight inflammation, will be the consequence. The same will take place when this substance is struck upon an anvil. This compound has been made the subject of many amusing experiments, by inclosing small quantities of it in glass beads, &c., and pasting paper over them; they are then called detonating balls. There are also detonating spiders, detonating letters, &c.

Throw 2 grains of detonating silver into a gallipot, containing 1 dram of nitric acid; explosion and inflammation will take place, and the acid will be thrown about.

Prepare a solution of nitrate of silver, and pour into it a solution of pure lime in water, as long as a precipitate will fall down. Filter the liquid, and wash the precipitate by pouring warm water on it, as it stands on the filter. Now put the powder into a warm place upon the paper, that it may be well dried; then put it into a wide-mouthed phial, containing pure liquid ammonia—cork it, and let it remain undisturbed for a whole day, or until the powder becomes black. Now pour off the supernatant liquor, and put the phial, open, in a place where the heat may not be more than 80° or 100°. When dry, this powder is very explosive, and should remain undisturbed in the phial where the process was finished; as sometimes, the least friction will cause an explosion of the whole mass. The lid of a pill-box is the best cover the phial can have, as frequently, in taking the powder out, a part adheres to the neck; and then, if a stopper or cork be put in, the friction occasioned even by this is sometimes sufficient to explode the whole. Perhaps, if all fulminating powders were dried in watch-glasses, and permitted to remain in them till wanted for use, it would be much safer.

Put 50 grains of mercury into a retort, and pour over it 6 drams of strong nitric acid; place the retort over a lamp until the metal is dissolved. Now pour an ounce of alcohol into a Florence flask, and when the nitrate is cold, pour it in also. Place the flask on the ring, at a considerable distance above the flame of the lamp, so as not to heat it too much at first: effervescence will soon commence, and a powder will be precipitated immediately. When the whole of the precipitate has fallen down, pour the contents of the flask on a filter, wash out the precipitate with water, and pour this also on the filter. When the liquor has passed through, pour distilled water over the powder, in order that it may be totally freed from the acid: this will be known by the water passing through quite tasteless. Collect the powder on a watch-glass, and dry it in a place, the temperature of which does not exceed 100°. This fulminating powder will weigh about a dram, and may be preserved either in a watch-glass, or in a wide-mouthed phial.

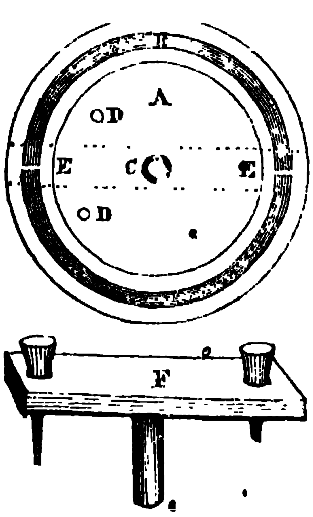
GALVANIC REVERSER.

(To the Editor.)

SIR.—I send you a description of a galvanic reverser, which is both cheap and effective. The insertion will oblige A. NICHOLSON.

A, piece of mahogany of any shape, having a turned groove, ¼ of an inch deep and wide, to hold mercury, and divided in a line with the centre, by two pieces of ivory or bone E E, to half the height of groove. F, piece of mahogany having a mercury cup, terminating in a point at each end; a stout wire fixed in the centre, fitting the hole C, and of a length just sufficient to allow the points to dip in the mercury. E E, holes communicating with the mercury groove to connect apparatus.

All that is necessary to set the instrument to work, is to adjust the piece F, so that the points will just pass over E E; put mercury in the cups, and in the groove nigh enough for the points to dip in it; connect the apparatus by wires, inserted in E E, and the battery by placing the poles in the mercury cups. A slight move of the piece F will now give the eastern or western rotation.



It is not necessary that the canal for the mercury should be much longer at each end than the dotted line, but I prefer its going all round for the more convenient removal of the mercury.

MEMORANDA.

Preservation of Fruits by Carbonic Acid.—The details of some very interesting experiments will be found in the *Ann. de Chim. et de Phys.* (Jan. 1819), tending to prove that fruits may be preserved by means of carbonic acid gas. Cherries, grapes, pears, apples, and chesnuts, were placed in glass vessels filled with this gas, obtained from carbonate of lime by sulphuric acid. Neither the color nor the taste of the cherries were altered at the end of fifteen days; and at the end of six weeks they were in the same state as if they had been preserved in brandy.

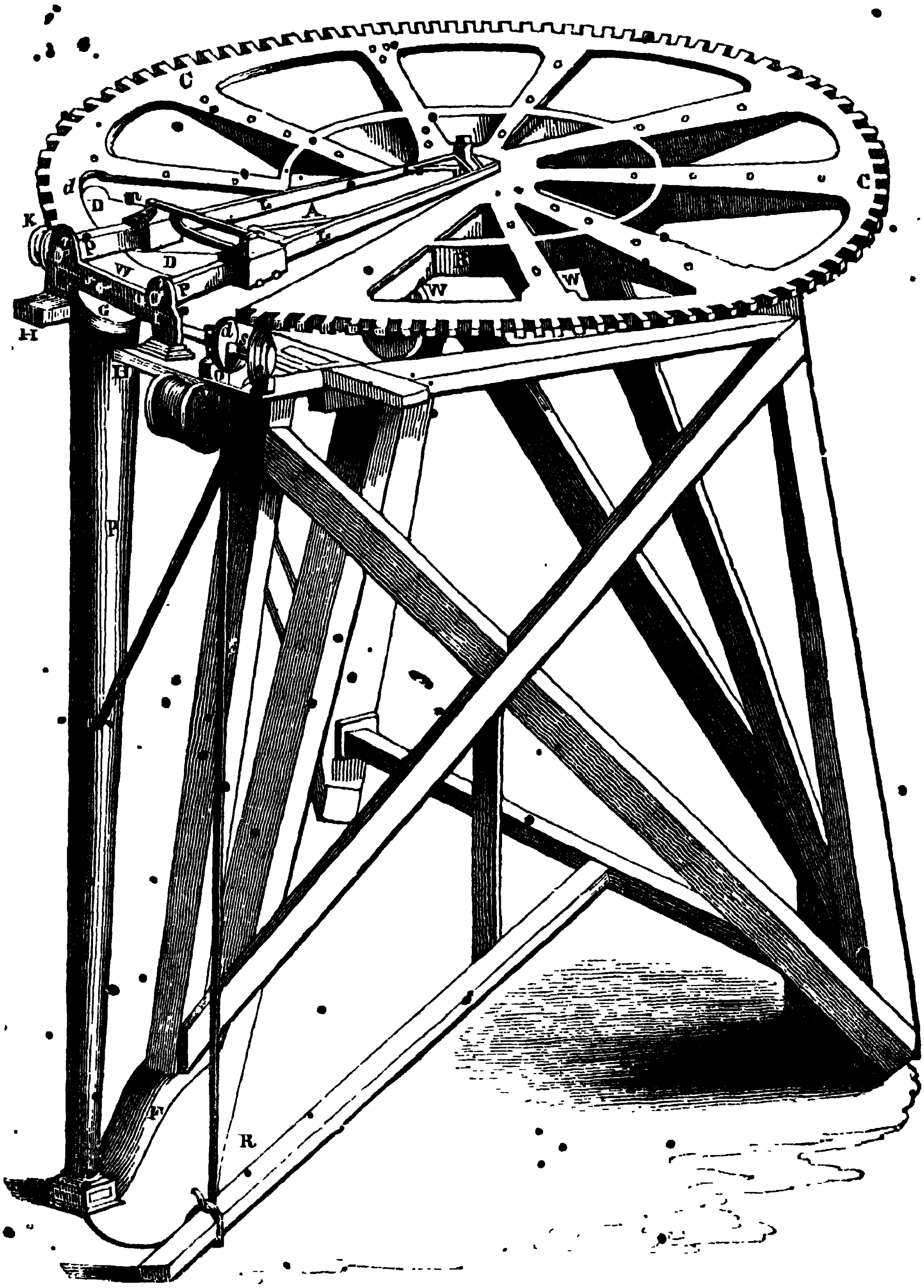
Vegetable Acids.—Vegetables yield nine several acids:—the oxalic in rhubarb; the tartaric in tamarinds, grapes, and mulberries; the citric in oranges, lemons, and onions; the malic in apples, cherries, &c., the gallic in elm, oak, &c.; the benzoic in balsamic trees; the prussic in laurel-leaves, peach-blossoms, and bitter kernels; phosphoric in barley, oats, &c.

Salt Mines.—The salt-springs of Cheshire and Droitwich contain 22 per cent. of salt. At Northwich is a bed of solid salt. In most countries, salt-rock is below the surface, but in Spain, &c., it is above. The salt-mountain at Cordova is 300 feet high; and there are others still higher, and several of them. In Tyrol, the salt-galleries are horizontal in a mountain. In Peru, salt-mines exist 10,000 feet above the sea. The Cheshire beds of red-salt rock are 20 to 30 yards thick, between thick beds of sandstone, limestone, and clay. At Cracow, the mines extend several miles in vast caverns, sustained by pillars of salt, and have been wrought for 12 or 13 centuries. Salt is either a result of the desiccation of salt-lakes, or an accumulation of horizontal strata, carried into masses by tides.

La Place on the Form and Structure of the Earth.—La Place has given the following very interesting results, as deduced from analysis, and from the experiments made with the pendulum in both hemispheres:—1. That the density of the strata of the terrestrial spheroid increases from the surface to the centre. 2. That the strata are, very nearly, regularly disposed around the centre of gravity of the earth. 3. That the surface of this spheroid, of which the sea covers a part, has a figure a little different from what it would assume in virtue of the laws of equilibrium if it became fluid. 4. That the depth of the sea is a small fraction of the difference of the two axes of the earth. 5. That the irregularities of the earth, and the causes which disturb its surface have very little depth. 6. That the whole earth has been originally fluid. "These results," says La Place, "of analysis and experiment, ought, in my opinion, to be placed among the number of truths which geology presents."

A cubic foot of air weighs 1·2 ounce; hence a column a mile high and one inch base, weighs 43·2 ounces, and 15 pounds is equal to 5·6 miles; it diminishes in weight as the height, and in elastic force or reaction as the bulk or cube of the height, both together as the biquadrate or fourth power; but in density as the logarithm of the height. Hence at 44 miles, where the atmosphere ceases to reflect the light, its density is considered only as a 10,000 of that at the surface.

A middle-sized man consumes 46,000 cubic inches, or 26 cubic feet of oxygen per day, making 20 respirations in a minute, and 1·62 cubic inches at each; that is 46,656 cubic inches in 28,800 respirations per day.



RAMSDEN'S DIVIDING MACHINE.

RAMSDEN'S DIVIDING MACHINE.

THIS valuable instrument is the invention of Mr. Jesse Ramsden, to whom the Commissioners of Longitude gave the sum of £615, upon his entering into an engagement to instruct a certain number of persons, not exceeding ten, in the method of making and using this machine, in the space of two years, say, from the 28th October, 1775, to 28th October, 1777; also binding himself to divide all sectants and octants by the same engine, at the rate of three shillings for each octant, and six shillings for each brass sectant, with Nonius's divisions to half minutes, for as long time as the Commissioners should think proper to let the engine remain in his possession. Of the sum £300 were given to Mr. Ramsden, as a reward for the usefulness of his invention; and £315 for his giving up the property of it to the Commissioners.

The following is the description of the engine given by Mr. Ramsden, upon oath:

This engine consists of a large wheel of bell-metal, supported on a mahogany stand, having three legs, which are strongly connected together by braces, so as to make it perfectly steady. On each leg of the stand is placed a conical friction-pulley, whereon the dividing wheel rests; to prevent the wheel from sliding off the friction-pullies, the bell metal centre under it turns in a socket on the top of the stand.

The circumference of the wheel is ratched or cut into 2160 teeth, in which an endless screw acts. Six revolutions of the screw will move the wheel a space equal to one degree.

Now a circle of brass being fixed on the screw-arbor, having its circumference divided into sixty parts, each division will, consequently, answer to a motion of the wheel of ten seconds, six of them will be equal to a minute, &c.

Several different arbors of tempered steel are truly ground into the socket in the centre of the wheel. The upper parts of the arbors, that stand upon the plane, are turned of various sizes, to suit the centres of different pieces of work to be divided.

When any instrument is to be divided, the centre of it is very exactly fitted on one of these arbors; and the instrument is fixed down to the plane of the dividing wheel, by means of screws, which fit into holes made in the radii of the wheel for that purpos

The instrument being thus fitted on the plane of the wheel, the frame which carries the dividing point is connected at one end by finger-screws, with the frame which carries the endless-screw; while the other end embraces that part of the steel arbor which stands above the instrument to be divided, by an angular notch in a piece of hardened steel; by this means both ends of the frame are kept perfectly steady and free from any shake.

The frame carrying the dividing-point or tracer, is made to slide on the frame which carries the endless-screw to any distance from the centre of the wheel, as the radius of the instrument to be divided may require, and may be there fastened by tightening two clumps; and the dividing-point or tracer, being connected with the clumps by the double-jointed frame, admits a free and easy motion towards or from the centre for cutting the divisions, without any lateral shake.

From what has been said, it appears that an instrument thus fitted on the dividing-wheel, may be moved to any angle by the screw and divided circle on its arbor; and that this angle may be marked on the limb of the instrument with the greatest exactness by the dividing-point or tracer, which can only move in a direct line tending to the centre, and is altogether freed from those inconveniences that attend cutting by means of a straight edge. This method of drawing lines will also prevent any error that might arise from an expansion or contraction of the metal during the time of dividing.

The screw-frame is fixed on the top of a conical pillar, which turns freely round its axis, and also moves freely towards or from the centre of the wheel, so that the screw-frame may be entirely guided by the frame which connects it with the centre: by this means any eccentricity of the wheel and the arbor would not produce any error in the dividing; and by a particular contrivance, the screw when pressed against the teeth of the wheel always moves parallel to itself; so that a line joining the centre of the arbor and the tracer continued will always make equal angles with the screw.

The large wheel A is 45 inches in diameter, and has 10 radii, each being supported by edge-bars. These bars and radii are connected by a circular ring B, 24 inches in diameter and 3 inches deep; and, for greater strength the whole is cast in one piece in bell-metal.

As the whole weight of the wheel A rests on its ring B, the edge-bars are deepest where they join it; and from thence their depth diminishes, both towards the centre and circumference.

The surface of the wheel A was worked very even and flat, and its circumference turned true. The ring C, of fine brass, was very exactly on the circumference of the wheel; and was fastened thereon with screws, which, after being screwed as tight as possible, were well riveted. The face of a large chuck being turned very true and flat in the lathe, the flattened surface A, of the wheel, was fastened against it with hold-fasts; and the two surfaces and circumference of the ring C, a hole through the centre and the plane part round it, and the lower edge of the ring B, were turned at the same time.

D is a piece of hard bell-metal, having a hole, which receives the steel arbor D, made very straight and true. This bell-metal was turned very true on an arbor; and the face, which rests on a wheel; was turned very flat, so that the steel arbor D might stand perpendicular to the plane of the wheel; this bell-metal was fastened to the wheel by six steel screws.

A brass socket Z is fastened on the centre of the mahogany stand, and receives the lower part of the bell-metal piece D, being made to touch the bell-metal in a narrow part near the mouth, to prevent any obliquity of the wheel from bending the arbor; good fitting is by no means necessary here; since any shake in this socket will produce no bad effect, as will appear hereafter when we describe the cutting-frame.

The wheel was then put on its stand, the lower edge of the ring B, resting on the circumference of three conical friction pulleys W, to facilitate its motion round its centre. The axis of one of these pulleys is in a line joining the centre of the wheel and the middle of the endless-screw, and the other two placed so as to be at equal distances from each other.

The lower extremity of the conical pillar P, terminates in a cylindrical steel pin, which passes through and turns in the transverse axis H, and is confined by a check and screw.

To the upper end of the conical pillar is fastened the frame G, in which the endless-screw turns; the pivots of the screw are formed in the manner of two frustrums of cones joined by a cylinder. These pivots are confined between half-holes, which press only on the conical parts, and do not touch the cylindric parts; the half-holes are kept together by screws, which may be tightened at any time, to prevent the screw from shaking in the frame.

On the screw-arbor is a small wheel of brass K, having its outside edge divided into sixty parts, and numbered at every sixth division with 1, 2, &c., to 10.. H, represents a part of the stand, having a parallel slit in the direction towards the centre of the wheel, large enough to receive the upper part of the conical brass pillar P, which carries the screw and its frame; and as the resistance, when the wheel is moved by the endless-screw, is against the side of the slit H, which is towards the left hand, that side of the slit is faced with brass, and the pillar is pressed against it by a steel spring on the opposite side; by this means the pillar is strongly supported laterally, and yet the screws may be easily pressed from or against the circumference of the wheel, and the pillar will turn freely on its axis to take any direction given to it by the frame L.

L, is a brass frame, which serves to connect the endless-screw, its frame, &c., with the centre of the wheel; each arm of this frame is terminated by a steel screw, that may be passed through any of the holes in the piece Q, as the thickness of the work to be divided on the wheel may require, and are fastened by the finger-nuts.

At the end of this frame is a flat piece of tempered steel, wherein is an angular notch; when the endless-screw is pressed against the teeth of the circumference of the wheel, which may be done by turning the finger-screw S, to press against the spring T, this notch embraces and presses against the steel arbor D. The bottom of this slide has a notch K, whose plane is parallel to the endless-screw, and by the point of the arbor D, resting in this notch, this end of the frame is prevented from tilting. The screw S, is prevented from unturning, by tightening the finger-nut W.

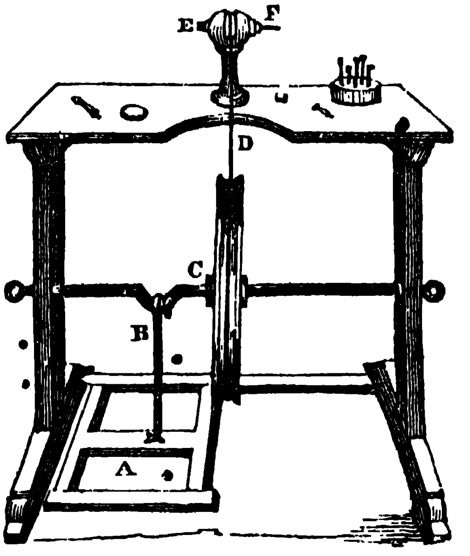
THE FIGURED STONES OF EGYPT.

New and successful microscopic observations on the figured stones of Egypt, have enabled Ehrenberg to ascertain that these configurations, resembling the corpuscles of Kaolin and chalk, but in gigantic proportions, have in all probability been produced by the same agents as the corpuscles of the latter, only with grosser materials. In fact, we immediately recognize in these Egyptian formations, whether they be in rings, discs, or spheres, and varying in size from an inch to a foot, the animals of the chalk (for example, *Textielaria globulosa)* whose undissolved calcareous coverings have been subjected, in the progress of their formation, to a force which has disposed them in annular series. These are appearances altogether different from those presented by the flints and jaspers of Egypt, in which we meet with imbedded *Polythalamia* only here and there. The latter are not the corpuscles themselves, but only their form silicified by a chemical operation, the nature of which is unknown to us.* The small visible calcareous coverings obtained by acids in the soluble layers of the figured Egyptian stones, shews distinctly that the operation to which they owe their present condition did not consist of a composition and substitution, and that it was not of a chemical nature; that it did not take place slowly, and in a continuous manner, but that it was the calm and tranquil result of a mechanical decomposition. It may easily happen, that we may accidently notice, in a chemical operation, certain identical parts which have undergone no change, notwithstanding the alteration of the principal mass, just as we find unaltered flour in the dough of bread, chalk in silex, or foreign substances imbedded in crystals; but hetrogeneous portions, arranged in a series of regular formation, present a character peculiar to the configurations in question, in which are formed, in a manner altogether remarkable and different from what is usually observed, and under the influence of a particular force, lapideous rings, free, concentric, and unconnected with each other; between which, alternate layers of lime, with the animalcules of the chalk are deposited, giving rise to forms having a solid nucleus with a free but solid ring, suggesting to the fancy the figure of Saturn and his ring.—*Jameson's Edin. Phil. Journ.*

SEAL ENGRAVING.

The art of engraving gems is one of extreme nicety. The stone having received its desired form from the lapidary, the engraver fixes it by cement to the end of a wooden handle, and then draws the outline of his subject, with a brass needle or a diamond, upon its smooth surface.

The engraving represents the whole of the seal engraver's lathe. It consists of a table on which is fixed the mill, a small horizontal cylinder of steel, into one of whose extremities the tool is inserted, and which is made to revolve by the usual fly-wheel driven by a treadle. The tools that may be fitted to the mill-cylinder are the following: a hollow cylinder, for describing circles and for boring; a knobbed tool, or rod terminated by a small ball; a stem terminated with a cutting disc, whose edge may be either rounded, square, or sharp, being in the last case called a saw.



A is the treadle which works the lathe. B the crank. C the foot wheel. D the cord. E the head or mandril. F a tool placed in the mandril. The engraver holds the stone cemented on to a piece of stick by means of a sealing-wax cement.

Having fixed the tool best adapted to his style of work in the mill, the artist applies to its cutting point, or edge, some diamond-powder, mixed up with olive oil; and turning the wheel, the holds the stone against the tool, so as to produce the wished-for delineation and erosion. A similar apparatus is used for engraving on glass.

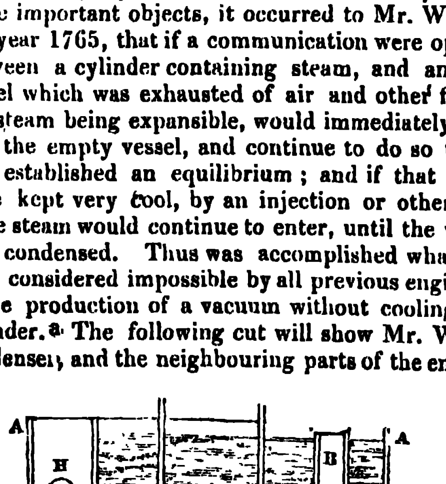
In order to give the highest degree of polish to the engraving, tools of boxwood, pewter, or copper, bedaubed with moistened tripoli or rotten-stone, and lastly, a brush, are fastened to the mill. These are worked like the above steel instruments. Modern engravings on precious stones have not in general the same fine polish as the ancient.

STEAM AND THE STEAM ENGINE.

(Resumed from page 390 and concluded.)

The name of Watt, using it in connection with the steam engine, is certainly the greatest name that this history furnishes. Before his time, the steam engine was a mere toy compared to that stupendous machine it became in his hands. Refer to any of those engines we have described, and it will be found that the same vessel acted as a steam cylinder and as a condenser; at one moment a vast quantity of steam was wasted to heat it, at another, a proportionably large quantity of water was necessary to condense such part of the steam as had produced the stroke,—for it will be observed, that the cylinder was heated and cooled at every stroke of the engine at a vast expenditure of power; for, as Watt observed, that in order to obtain the greatest power from the steam, the cylinder should always be kept as hot as the steam which entered it; that when the steam was condensed, the water of condensation, and the water of injection should be cooled to 100° Fahr., or lower if possible.

Pondering upon the method of accomplishing these important objects, it occurred to Mr. Watt in the year 1765, that if a communication were opened between a cylinder containing steam, and another vessel which was exhausted of air and other fluids, the steam being expansible, would immediately rush into the empty vessel, and continue to do so till it had established an equilibrium; and if that vessel were kept very cool, by an injection or otherwise, more steam would continue to enter, until the whole was condensed. Thus was accomplished what had been considered impossible by all previous engineers—the production of a vacuum without cooling the cylinder.[a] The following cut will show Mr. Watt's condenser, and the neighbouring parts of the engine.



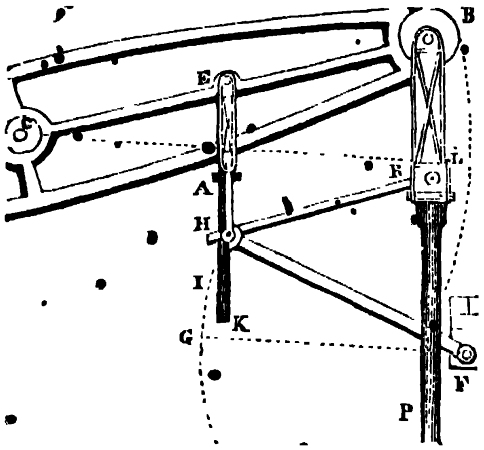
A A A, is a cistern of cold water, situated beneath the steam cylinder. B, is a pipe connected with the cylinder. C, the condenser. D, a valve opening from it to E, which is called the air pump. The valve G opens into a small cistern, called the hot water cistern; and the circle H is the end of a pipe which leads to a pump called the hot water pump, and which leads to and supplies the boiler with hot water; the surplus running off. I, is a pipe leading to a cold water cistern at top, and by an injection cock and a rose into the condenser beneath. Before the engine is set going, the injection cock is closed, and steam is admitted to the cylinder and the condenser, a part of the steam escapes through the valve M, and carries the air with it from C. The injection cock is then opened, and cold water being admitted, the steam is condensed, and the piston of the steam cylinder descends. When the piston of the cylinder rises, that of the air pump also rises, and leaves a vacuum beneath at E; the valve D therefore opens and admits into E the condensed steam of C. The next downward stroke forces it through the valves of the piston at E, and it is discharged at G; admission and condensation of steam going on at C as before, C receiving the steam of the cylinder at each stroke of the engine.

It next occurred to Mr. Watt, that the mouth of the cylinder being open, the air which entered to act on the piston, would cool the cylinder, and condense some steam on again filling it. Then he proposed "to put an air-tight cover on the cylinder, with a hole and stuffing box for the piston to slide through, and to admit steam above the piston, to act upon it instead of the atmosphere." This was his second grand improvement, and while the power of the mechanism remain untouched, the expense of fuel and waste of steam was reduced to nearly a third of its former amount, and the machine was now, properly, an engine moving by the force of *steam;* the motive power being derived previously from the gravity of the atmosphere.

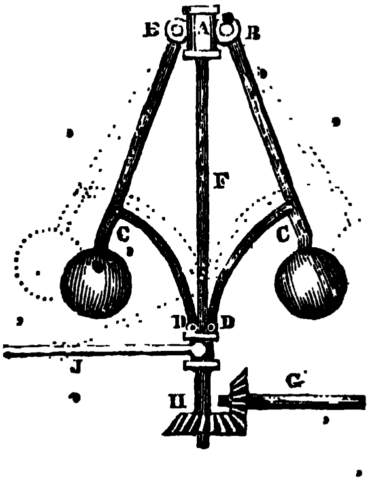
The other source of the loss of heat, by the air of the atmosphere cooling the cylinder externally, which produced a condensation of the internal steam, was obviated in thought by inclosing the steam cylinder in another of wood, or of some other substance, which would conduct heat slowly. Hence the origin of steam jackets.

It required but little contrivance after the invention of a close cover to the cylinder, to make the steam drive the piston down as well as up, all that was necessary, being a set of valves of such a nature as to admit steam alternately into one, and the other end of the cylinder, and discharge it from one part, as it was admitted into the other. But a difficulty arose relative to the beam above. When the piston was driven down by the atmosphere, a chain reaching from the piston rod to the beam was all sufficient; but when the piston rod was to push the beam up as well as down, the chain became inapplicable, a rack on the piston rod and corresponding teeth on the end of the beam was suggested, but soon abandoned, being noisy, unsteady, and producing much friction. There again Mr. Watt showed his transcendent talents by the invention of the parallel motion, certainly one of the most beautiful contrivances that art or talent could suggest; it is shown beneath—its object is to keep the piston rod sufficiently fixed to the beam to move it up and down, and yet keep perfectly parallel its course up and down.

Suppose R is the head of the piston rod. B the end of the beam; this of course describes the segment of a circle. The parallel motion consists of the moveable rods, which connect P R with the beam. F is a fixed point, all the rest is moveable. As P is pulled down the moveable end of F H, it moves in the segment I G J; while B describes the segment B L. Thus the beam would project the end of the piston rod outwards, but the bar F H, which is connected with it, by means of the intermediate bar H R, would project it inwards ; these contrary motions destroy each other, and the piston rod remains vertical throughout its course—so also does the rod of the air pump A K.

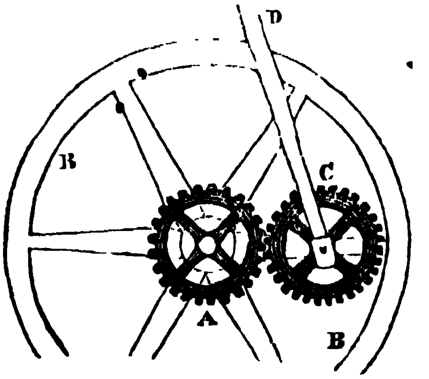


Another difficulty to overcome was the irregularity of the admittance of the steam, which fluctuated from various causes, particularly the state of the fire. To obviate this, Mr. Watt suggested another great improvement, a self-acting *throttle valve,* so adjusted, that when the piston was moving with too great a velocity, it would admit less steam into the cylinder, and so diminish its speed ; and, on the contrary, admit a greater quantity when it was moving too slow. This important purpose, Mr. Watt accomplished by an adaptation of the *tent lifter,* previously used for an analogous object in mills ; this contrivance is usually called the governor, and may be thus represented and described :—

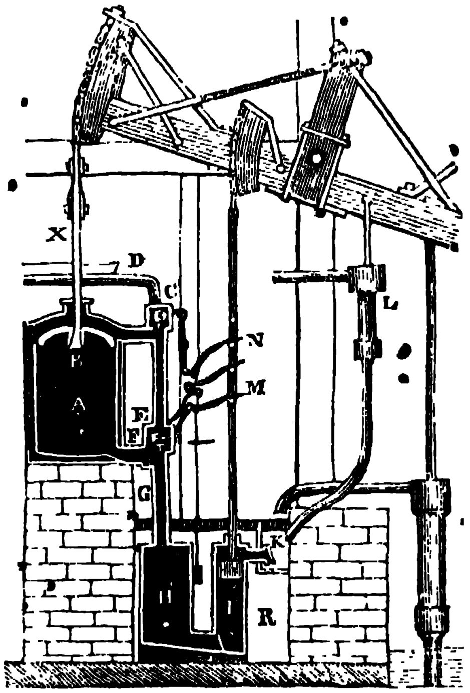


The two balls C C are attached by bars to two joints above B B. They are connected below to two moveable bars, which reach down to D D, where they are attached to a socket, capable of moving up and down the rod F. Suppose Q to be turned round by the fly-wheel, or by any other part of the engine, it would by means of the bevelled wheel at the end of it, round the wheel H, and this the spindle F. As this turns more or less rapidly, so will of course the balls fastened to it turn also, and by centrifugal force, the faster they move the higher they will be elevated, assuming with rapidity of motion the position of the dotted lines as they rise ; the socket D rises and pulls up the end of the rod F ; the other end of which moves the throttle valve, or that valve which admits steam from the boiler to the cylinder, and thus the supply of steam is regulated.

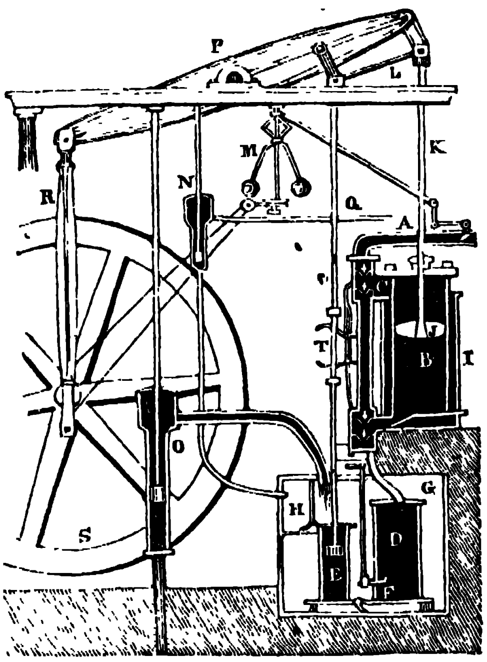
Another very great improvement to ensure equality of motion was the application of a crank and fly-wheel, but as Mr. Watt's idea was communicated to other parties before he had put it in practice, he thought proper to avail himself of what has been since called the *sun* and *planet* wheels,—a contrivance easily understood by the mere representation of it.



Such are but a few only of the inventions of Mr. Watt, space not permitting us to expatiate more upon the subject ; we give below, however, the first and second engine of this admirable mechanic, with a view to comparison with each other, and with former engines ; a long description is unnecessary, therefore we shall merely refer to the various parts.



A is the steam cylinder. B the piston. C the upper valve. D the steam pipe. E the lower valve. F the passage to the cylinder. G the pipe leading to the condenser H. I the air pump. L the hot water pump. M N the tappets which work the valves. O the cold water pump, which supplies the cistern R. It will be remarked, that the improvements shown in this over former engines, is in the cover to the cylinder, its case or jacket : the valve from the top and bottom of the cylinder, the hot and cold water pump, and the condenser and air pump. The defects are that there is no fly-wheel, and no governor. These are shown in the following, besides a very superior beam, and mode of attachment of the piston rod to it, by means of the parallel motion.



SAFFRON

Is the stigmata of the *crocus officinalis*, dried on a kiln, and pressed into cakes. It is grown in various parts of Europe, as well as in this country. A tract of land about ten miles across is applied to the culture of this valuable product in Cambridgeshire. The greater part of this tract is an open level country, with few inclosures; and the practice there is to crop the plants for two years, and then let it lie fallow the third. For planting, the fallow ground is well ploughed and manured, and afterwards dug by a narrow spade into trenches, wherein the roots are put, and subsequently covered over in forming the next trench, the roots in which are in like manner covered with the earth from the succeeding one. The quantity of roots planted on an acre is about 128 bushels. About the end of September the flowers appear. They are gathered before they are full blown, as well as after, and the proper time for it is early in the morning. The owners of the saffron-fields get together a sufficient number of hands, who pull off the whole flowers, and throw them by handsful into a basket, and so continue till about eleven o'clock. Having then carried home the flowers, they immediately fall to picking out the stigmata or chives, and together with them a pretty large proportion of the stylus itself, or string to which they are attached; the rest of the flower they throw away as useless. Next morning they return to the field, without regarding whether the weather be wet or dry: and so on daily, including Sundays, till the whole crop is gathered.

The next labour is to dry the chives on the kiln. The kiln is built upon a thick plank, that it may be moved from place to place. It is supported by four short legs: the outside consists of eight pieces of wood of three inches thick, in form of a quadrangular frame, about twelve inches square at the bottom on the inside, and twenty-two on the upper part; which last is likewise the perpendicular height of it. On the fore side is left a hole of about eight inches square, and four inches above the plank, through which the fire is put in; over all the rest laths are laid pretty thick, close to one another, and nailed to the frame already mentioned. They are then plastered over on both sides, as are also the planks at bottom, very thick, to serve for a hearth; over the mouth is laid a hair-cloth, fixed to the edges of the kiln, and likewise to two rollers or moveable pieces of wood, which are turned by wedges or screws, in order to stretch the cloth. Instead of the hair-cloth, some people use a net-work of iron-wire, by which the saffron is soon dried, and with less fuel; but the difficulty of preserving it from burning makes the hair-cloth be preferred by the best judges. The kiln is placed in a light part of the house; and they begin with putting five or six sheets of white paper in the hair-cloth, and upon these they lay out the wet saffron two or three inches thick. It is then covered with some other sheets of paper, and over these they lay a coarse blanket five or six times doubled, or instead of this a canvas pillow filled with straw; and after the fire has been lighted some time, the whole is covered with a board having a considerable weight upon it. At first they apply a pretty strong heat, to make the chives sweat as they call it: and at this time a great deal of care is necessary to prevent burning. When it has been thus dried about an hour, they turn the cakes of saffron upside down, putting on the coverings and weight as before. If no sinister accident happen during these first two hours, the danger is thought to be over; and nothing more is requisite than to keep up a very gentle fire for twenty-four hours, turning the cake every half hour. That fuel is best which yields the least smoke; and for this reason charcoal is preferable to all others.

The quantity of saffron produced at a crop is uncertain; sometimes five or six pounds of wet chives are got from one rood, sometimes not above one or two, and sometimes not so much as is sufficient to defray the expense of gathering and drying; but it is always observed, that about five pounds of wet saffron go to make one pound of dry, for the first three weeks of the crop, and six pounds during the last week. When the heads are planted very thick, two pounds of dry saffron may, at a medium, be allowed to an acre for the first crop, and twenty-four pounds for the two remaining ones, the third being considerably larger than the second. To obtain the second and third crops, the labour of hoeing, gathering, picking, &c., already mentioned, must be repeated: and about Midsummer, after the third crop is gathered, the roots must all be taken up and transplanted. The best saffron has the broadest blades,—this being the mark by which English saffron is distinguished from the foreign; it ought to be of an orange or fiery-red color, and to yield a dark yellow tincture; it should be chosen fresh, not above a year old, in close cakes, neither dry nor yet very moist, tough and firm in tearing, of the same color within as without, and of a strong, acrid, diffusive smell. This drug has been reckoned a very elegant and useful aromatic; it imparts the whole of its virtue and color to rectified spirit, proof spirit, wine, vinegar, and water. A tincture drawn with vinegar loses greatly of its color in keeping; the watery and vinous tinctures are apt to grow sour, and then lose their color also; that made in pure spirits keeps in perfection for many years.

SPRING GARDENING.

THE months of March and April are among the busiest to the cultivator of the flower garden, as it is the season for sowing his seeds, preparing his hot beds, and trimming up his borders. These necessary duties are also accompanied by pleasures which are inherent, not merely to the subject but the season; for many an one neglectful of such matters at all other periods of the year, is now exhilirated in spirits, and induced to bodily exertion. Believing that such is the case with all others as well as ourselves—the following remarks on garden operations, and the cultivation of the tender annuals are well timed, and it is hoped useful.

Shrubs, except those which are very early in leafing, may still be removed in March, and evergreens are best removed at this season or in April. All perennials may be transplanted with perfect safety in March and April, and if the garden to which they are introduced is wet, or with a cold, clayey, or tenacious soil, they are much better removed now than in the autumn. The hardy annuals or those which grow entirely in the open ground, may be sown from the middle of March to the middle of May; that there may be a succession of flowers throughout the summer season. To sow them, first stir and smooth the ground, then, make a slight depression with the bottom of a garden pot, or else a round ring with the edge of the pot, and thinly scatter the seed over the smooth surface made, lastly, sprinkle some fine mould over it, covering the seed from an eighth of an inch to an inch, according to the size of the seed.

The tender annuals require greater care in their cultivation, indeed there are very few private persons who do not err most egregiously in endeavouring to raise cockscombs, balsams, and other plants of a similar character.

All tender annuals, to be flowered in the highest degree of perfection, must be raised on a *hot-bed;* which is a mass of any fermenting material, that in its decomposition produces a degree of heat considerably above that of the atmosphere in which it is placed. There are various matters which will answer for this purpose; some animal, others vegetable, and some even mineral, as for example, certain kinds of coal dross, containing pyrites; but as the most common, and that which is most easily within the means of the amateur who has but a small garden, is stable manure, we shall confine ourselves to giving directions for the management of that material. When obtained from the stables in, say a cart-load, which is quite sufficient for a small hot-bed, large enough for rearing annuals, it consists of two parts, the dung of the horse and long litter, or in other words straw, moistened and discolored, but not decayed. When the mass, thus formed, is laid in a heap, it generally produces a very powerful heat, too strong for being used as a hot-bed; for it should never be forgotten that too hot a bed is worse for the plants than sowing them in the open air. If the bed be much too hot, the plants will be blackened and ultimately destroyed; and even if only a little hotter than is necessary, the plants will be drawn up, and become too weak to have any chance of success when afterwards transplanted into the open air. As it is the fermentation occasioned by the decomposition of the straw contained in the manure which produces the violent heat, the heap should be turned over with a dung fork two or three times in the course of a fortnight, till the decomposition is considerably advanced, the whole mass of one color, and the straws, which were before tough, rendered sufficiently tender to be easily torn to pieces with the dung-fork When the mass is arrived at this stage, it may then be formed into a bed, which may be of any convenient length and breadth, according to the situation and other circumstances.

In general, such a bed is covered with what is called a hot-bed frame. This consists of a box without a bottom, and with a moveable top, formed of a glazed sash or sashes. For a small garden, a box three feet wide, and four feet from the back to the front, will be sufficient. The back of the box may be two feet high, and the front one foot. The hot-bed may be formed in an open situation, on a surface raised six inches above the general level; and it should be three or four inches wider on every side than the box that is to be placed on it. The cart-load of manure, which has been fermented and prepared for making up this hot-bed, should now be regularly spread over the base of the intended bed, and raised by successive layers to such a height as the quantity of manure will admit. If, in building the bed by these successive layers of manure, cinder siftings, and the animal and vegetable refuse of the kitchen, are mixed along with it, the heat will be the less violent at first, but it will be retained for a much greater length of time.

The time for making a hot-bed for raising seedling annuals need not be earlier than the middle of March, or beginning of April; since the plants which are raised in it cannot in general be turned out into the open air sooner than the middle of May. As soon as the manure is formed into a bed, and the upper surface rendered quite level, the frame and the sash should be set on it. In two days the disturbed fermentation will have recommenced, and a steam will be observed under the glass. The surface of the bed may now be covered three or four inches deep with any light garden soil, and the different kinds of seeds may be sown in pots and placed on its surface; or if there should not be much heat, or likely not to be much, the pots may be sunk into the manure. In other cases, where it is not thought necessary to sow the different kinds in pots, the covering of soil may be six or eight inches deep, and the seeds may be sown on it, in little square or round patches. This indeed is the common practice.

In such a hot-bed as we have described, formed of only one load of stable manure, there is very little danger of over-heating the soil; but it may be proper to observe, that neither the temperature of the soil, nor the atmosphere over it, should ever much exceed 60°. It may fall as low as 48°, or even 40°, without the slightest injury to the plants; and it may be raised as high as 80°, or even 90°, without killing them; but any degree above 60° is decidedly injurious, by increasing the rapidity of the growth of the plants, and rendering them weak and sickly, and unfit to be turned out into the open ground.

When the plants have come up, and shown two or three leaves, in addition to the cotyledons or seed-leaves, they require to be transplanted; and this may either be done into small pots, or into a bed of earth, placed on a hot-bed, formed in the same manner as the first, but with a smaller quantity of material, as much less heat is required. For a small garden, however, a second hot-bed is unnecessary; and all the transplanting and other processes preparatory to removal to the open ground, may be carried on in one hot-bed; care being taken to inure the plants to the open air by degrees, by tilting the sash up behind at all times, night and day; and after the plants are up, removing it altogether, during fine days. The great object to be kept in view, is to make the plants as strong and vigorous as possible before turning them into the open ground, and to give them air, or to thin and transplant them whenever they show symptoms of becoming weak or drawn up.

A hot-bed for tender annuals will never want what are called linings; as it is for the advantage of the plants that the heat should decline gradually as they increase in size, that they may be the more fit for transplanting, when the season arrives for them to be removed to the open ground.

The soil for growing tender annuals.—The soil used for filling the pots in which tender annuals are sown, should be as rich as possible, and yet quite open in its texture: it should also be free from grubs and the eggs of insects. As soil of this description is not to be procured without some trouble, we shall give the following directions for preparing it; the best soil is turf, but as this is usually full of worms and the eggs of insects, it will require the following preparation:—Take a spade deep of the surface of some good rich pasture; or if only the turf two or three inches thick, so much the better. Lay this up in a ridge, 18 inches wide at bottom, 3 feet high, and of whatever length may be required. Then take the fresh stable manure, which is to be used in making the hot-bed, before it has been turned over, and lay it all round the turf and over it, distributing it as equally as possible. If there is plenty of manure, in proportion to the quantity of turf, the turf may be easily heated to 200°, which will not only destroy all the insects, &c. but all the root and herbage, and moreover wonderfully enrich the soil, by the distillation of the gas evolving from the manure during its fermentation. The manure must be turned over once or twice, while covering the turf, to prepare it for making the hot-bed; and when it is ready, the ridge of turf must be removed to some shed, or airy place, to dry it, when it will be fit for use. This is the best possible soil for annuals; but when put into the pots, it must be mixed with a little vegetable mould, (formed of dead leaves laid in a heap, and turned over from time to time till they rot) and sand. An old hot-bed, or decayed dung of any kind, is not good for tender plants, as it is apt to turn the whole soil sour, or soddened (at least if much watered.) In the summer, turf may be seasoned without manure, by covering it with the short grass mown off the lawn, which will ferment; but this plan is very far inferior to the other, though it is superior to the old method of laying up the turf for a year or more before it was used. By the hot-dung process, it will be ready in ten days; and not more should be prepared than will be wanted for one season's sowing and transplanting.

Watering.—There are few points in which gardeners are so apt to err as in watering; and the general fault is, that they give their plants too much. This is a fatal error for plants in pots, since over-watering will soon bring on the evils attendant on imperfect drainage; it is even dangerous to syringe the plants too much, though a little water thrown over their leaves occasionally is very useful in refreshing them. If the plants should become dusty, or infected with insects, the pot should be carefully turned on its side before the syringe is applied; and this plan has only the advantage of saving the soil in the pot from becoming sodden with too much water, but also of enabling the operator to wash the lower sides of the leaves, where the red spider, one of the greatest enemies of plants in pots, generally commences its depredations. When the plant is too large or too delicate to admit of the pot being laid on its side, two pieces of board with a notch cut in each, to allow room for the stem of the plant, and wider than the rim of the pot, should be laid over the earth, so as to carry off the water that falls from the leaves.

ACARUS GALVANICUS, OR ACARUS CROSSII.

OUR readers will remember the excitement caused in the year 1837 by the announcement, that Mr. Crosse, of Broomfield, had observed the developement of certain insects incident to the long-continued action of galvanism. Little additional information on this mysterious subject has since transpired, till Tuesday, the 15th instant, when a paper from Mr. Weekes, of Sandwich, was read before the *London Electrical Society*, detailing the successful repetition of Mr. Crosse's experiments. Among the cavilling which arose in connection with the original experiments, the possibility was urged that the ova of the insects might be in the air. Mr. Weekes's experiments were so conducted that this objection can be scarcely tenable. A well charred block of beech, containing a circular groove, to receive a bell-glass, was the base of the instrument. The groove was filled with mercury. A tumbler, containing the solution of silicate of potass, was beneath the bell; the silica was obtained by subjecting to a furnace heat a piece of fine black flint, obtained out of the centre of a "bowlder," selected from amongst those lying on the shore at Sandwich. The silica was united to the potass by a furnace heat; the result quenched in boiling water. The solution was immediately covered and filtered under cover. All things being prepared, the voltaic current was sent through the solution on the 3rd of September, 1841; and from that date to the present time the apparatus has not been disturbed. At the end of October, 1841, the first insect was observed, on the 16th of November, five were discovered. Since that date insects have been repeatedly seen. We must not omit to mention that the bell-glass was placed in total darkness, the screen being only removed when the progress was being examined. Mr. Weekes mentioned that he had another apparatus in action, very similar to this, with the exception that the bell is filled with oxygen; and expressed an anticipation that he should sooner or later detect insect life there. This expectation was realized a few days ago. In an appendix to his communication, dated February 27th, he states, that on the previous morning, he perceived eight or ten full-grown acari in vigorous locomotion on the inner surface of the air bell.—*Times.*

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